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ADAPTATION TO HIGH ALTITUDE COLD IN THE ANDES

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The problem of human accommodation to a cold environment is evaluated and a framework of the interacting biological and cultural adjustments possible is developed. Data are presented on the cultural and biological accommodations which permit the stable functioning of a native community in the cold environment of the high Andes.

Items of material culture which provide cold protection are described in relation to this function and data on the efficacy of some of these items, such as fire use and house form, are presented. Behavior patterns during working and sleeping periods are also described in relation to cold stress protection. Similar data on another community is presented to demonstrate the basic highland uniformity in cultural accommodations.

Total body cooling and "Lewis Wave" studies were made on U. S. Whites, University of Cuzco Whites, and Indian students and on native villagers in order to assess possible biological adaptation to cold. The results suggest that the natives have an acclimatizational change in metabolism which raises heat production during cold exposure and a genetically based increase in extremity blood flow when exposed to extreme finger cooling. The relationship between the cultural and biological accommodations to cold and their possible interaction with accommodation to altitude stress is briefly discussed.

Human Accommodation to Environmental Stress

Man has available a variety of accommodative mechanisms when exposed to a stressful climatic environment. These mechanisms permit a greater range of adjustment than can be made by most animal species because they include cultural parameters. Indeed, man's methods of adjusting to climatic environment may be categorized under two broad rubrics, - cultural adjustments and biological adjustments. A further subdivision of these categories leads to two major cultural divisions. (1) Man may adjust by a modification of his material culture in such a way that the material culture provides him with protection against the climatic environment. Housing and clothing, for example, can provide protection against cold, radiation, and even some forms of heat. (2) Man may adjust by behavioral modification. While behavioral adjustment is not simply culturally conditioned, it may be conveniently categorized as a cultural accommodation.

Within the biological adjustments to environment which man has available there are also two general categories. (1) Individual adjustment may be by acclimatization which is the potential to accommodate in the biological system that is species wide and that may be considered part of human genetic plasticity. The acclimatization may be a rapid one requiring only a matter of weeks or it may be one that occurs during the growth process and may be thus termed developmental. (2) Man may adjust by genetic adaptation, the general evolutionary mechanism of adaptation to environmental stress available to all animal species.

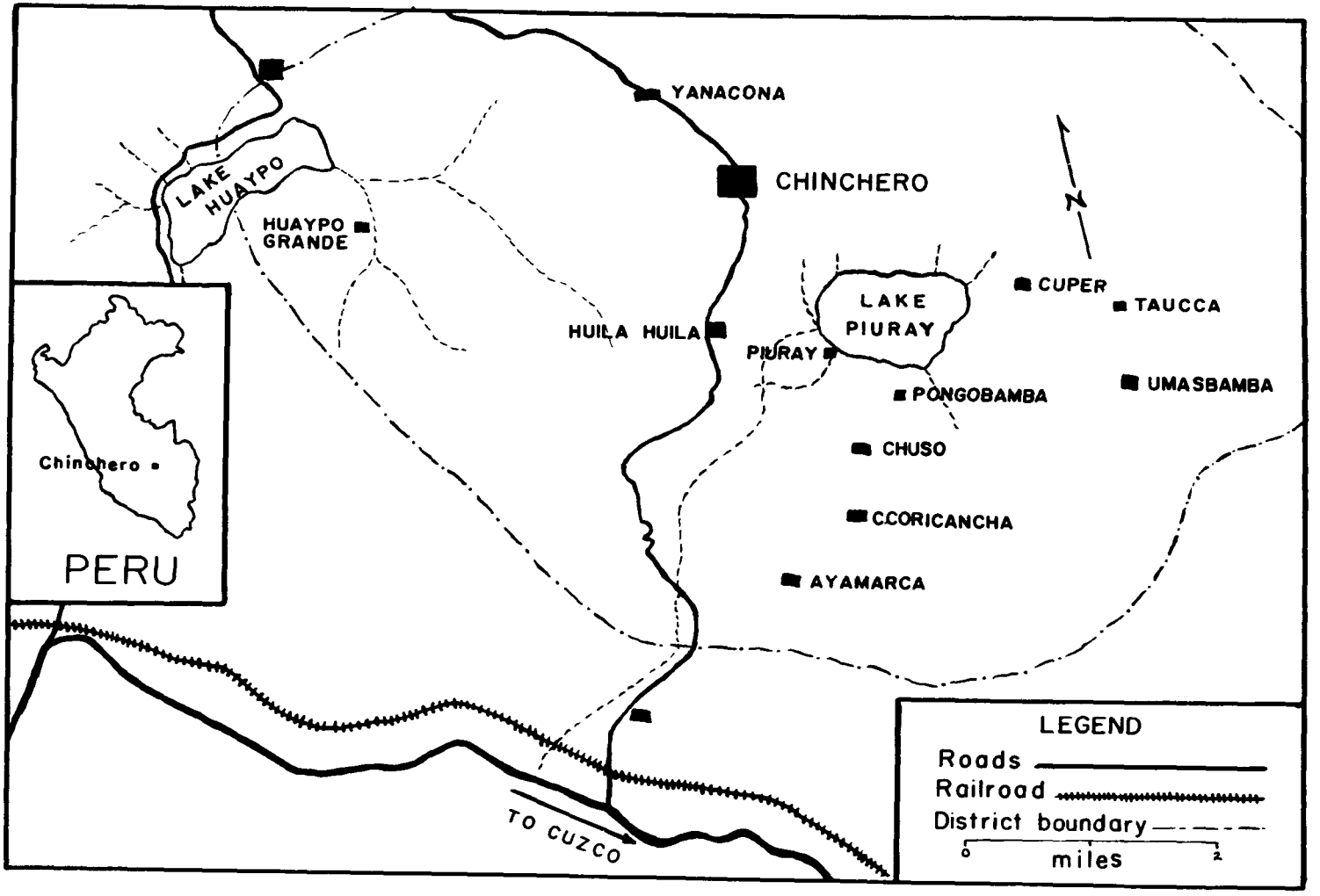
The length and severity of the environmental stress which man experiences will help to determine both the success and the nature of the accommodating mechanisms that are utilized. Accommodation responses are elicited by environmental stress even when permanent adjustment is impossible because of the extreme stress level. For example, men make acclimatization responses, which are partically successful, to environmental stresses such as altitudes above 16,000 feet. This type of accommodation is a temporary one which over an extended time period ends in physical deterioration.

Similar situations may occur with exposure to climatic stress. It seems probable that if some individuals were exposed nude for a continuous period to temperatures below 60° Fahrenheit, then without cultural adjustments the organism could probably not make a successful adaptation. As the stress becomes milder and the period of time in which accommodation or acclimatization can take place is extended, the possibility of more permanent adjustment occurs.

With prolonged stress, the culture of a group will also display accommodational aspects. Some of these cultural adjustments must be considered transient ones since they are self terminating. For example, modern U.S. and European cultures have a transient accommodation to the climatic stress, because at present they are dependent on fossil fuel resources for accommodation to the cold

environment. These fuel resources are not permanent ones and indeed they are gradually being depleted. Since this is not a stable ecological condition this adjustment can not be considered a permanent or semi-permanent adjustment in ecological terms. New fuel sources must be found or new methods of accommodation must be developed. It would appear that only more primitive societies without a history of recent population growth may be considered as showing stable adjustments to climatic stress. Cultures, such as the Eskimo, have made an adjustment which may be considered more permanent. In terms of ecological theory, their society and the human biological organisms that maintain it have made an adjustment which as far as we can see will not be inevitably terminal. The adjustment between man and environment is stable and will not deplete the resources that the group uses to make the adjustment nor will it be necessary for further modification in the human organisms to occur. It, therefore, appears that if we wish to understand how man can make a permanent adjustment to a stressful climatic environment, we must study societies and the men who live in them which have reached this stable condition.

A research program was formulated to study such stable adjustments in the stressful cold climate of the high altitude Andes and in the hot wet environment of the Amazon jungle basin. Two communities were chosen to reflect a stable adjustment where a historical process had not yet changed the general societal structure and where the human beings living in the society represented genetically stable units which had not had major admixture in recent times. The community chosen to show altitude stress was a Peruvian community sufficiently high in the Andes so that significant cold stress existed. The jungle community chosen was one along the head waters of the Amazon where climatic conditions produced significant hot wet heat stress. The study of these adjustments to the environment was conducted using general anthropological and physiological methodology. Societal and cultural adjustments were studied with conventional ethnographic methods while the biological adjustments were studied through anthropometric and simple experimental physiological techniques. The stability of the societal adjustments to climatic environment was checked in both communities by brief surveys of comparative communities in the same ecological zone and by the compilation of historical documentation to show stability in the society. The validity of the biological adaptations were ascertained by using control populations of native Peruvians with different genetic and/or cultural backgrounds. In the present report only the studies of accommodation to cold will be reported in detail, pending the complete analysis of the material collected on the community in the jungle.



DISTRICT OF CHINCHERO

STUDIES OF CULTURAL ADJUSTMENT TO COLD

CHINCHERO

General Description

The community chosen for the cold study is called Chinchero. Chinchero is both the name of the central community and of the political district. This district is one of seven districts in Urubamba Province, Department of Cuzco. The central town lies some 25 kilometers northwest of the city of Cuzco in the Peruvian Andes. Its exact location is shown on the accompanying map. The district contains several small communities which are known as ayllus and is about 15 kms. in diameter. The elevation in this district varies about one thousand meters but the majority of the population lives above 3600 meters (12,000 feet). The central town is 3,762 meters above sea level. The population of the district in 1960 was 6,385 individuals and had a slight predominance of women with 3,383 females to 3,002 males. Of the total population, approximately 2,000 lived in the central town while the rest maintained their residence in the outlying ayllus. However, many families had a house in both the central town and in an outlying ayllu.

The population of this district is divided into three social classes. These are (1) Mestizos, (2) Cholos, and (3) Indigenas. Despite the apparent racial nature of these terms, the social class is not based upon race as defined genetically. The Mestizo is the highest social class of the three. Mestizos may be identified by the fact that they speak Spanish and generally wear Western clothes. Although the Western clothes worn by the men and women are generally not the same as those worn in large cities, they are manufactured clothes and include the use of shoes for both sexes. Living style is not greatly different from the other two classes except for slightly larger houses and more food. This class contains all of the shop keepers and politically important individuals in the community. The class is very small constituting less than one percent of the population. The next class, the Cholos, also dress in modified Western fashion and the men generally speak Spanish well. Their dress consists of primarily Western clothing although in this class the man is likely to wear a poncho or native covering over his Western clothing and instead of wearing manufactured shoes is likely to wear a simple type of sandal made from old automobile or truck tires. The women wear a mixture of Western and traditional Indigena dress. They generally do not wear shoes and may not speak Spanish. This group also forms a small class in the community and while the data is not available to estimate exact percentages, it would probably be less than five percent.

The mass of the population is thus the Indigena. The Indigena is the farmer and traditional agriculturist of the area. Both males and females wear traditional Indian dress which was derived from early Spanish influence. However, the men may wear some items of more recent Western clothing, for example, the pants or shirt. The man may also, on occasion, wear the rubber tire sandals although he is likely to go barefooted when working in the field. The men in this class typically speak very little, if any, Spanish and the women speak only the native language Quechua. More detail on the clothing will be provided under the section dealing with clothing as a protection against the environment.

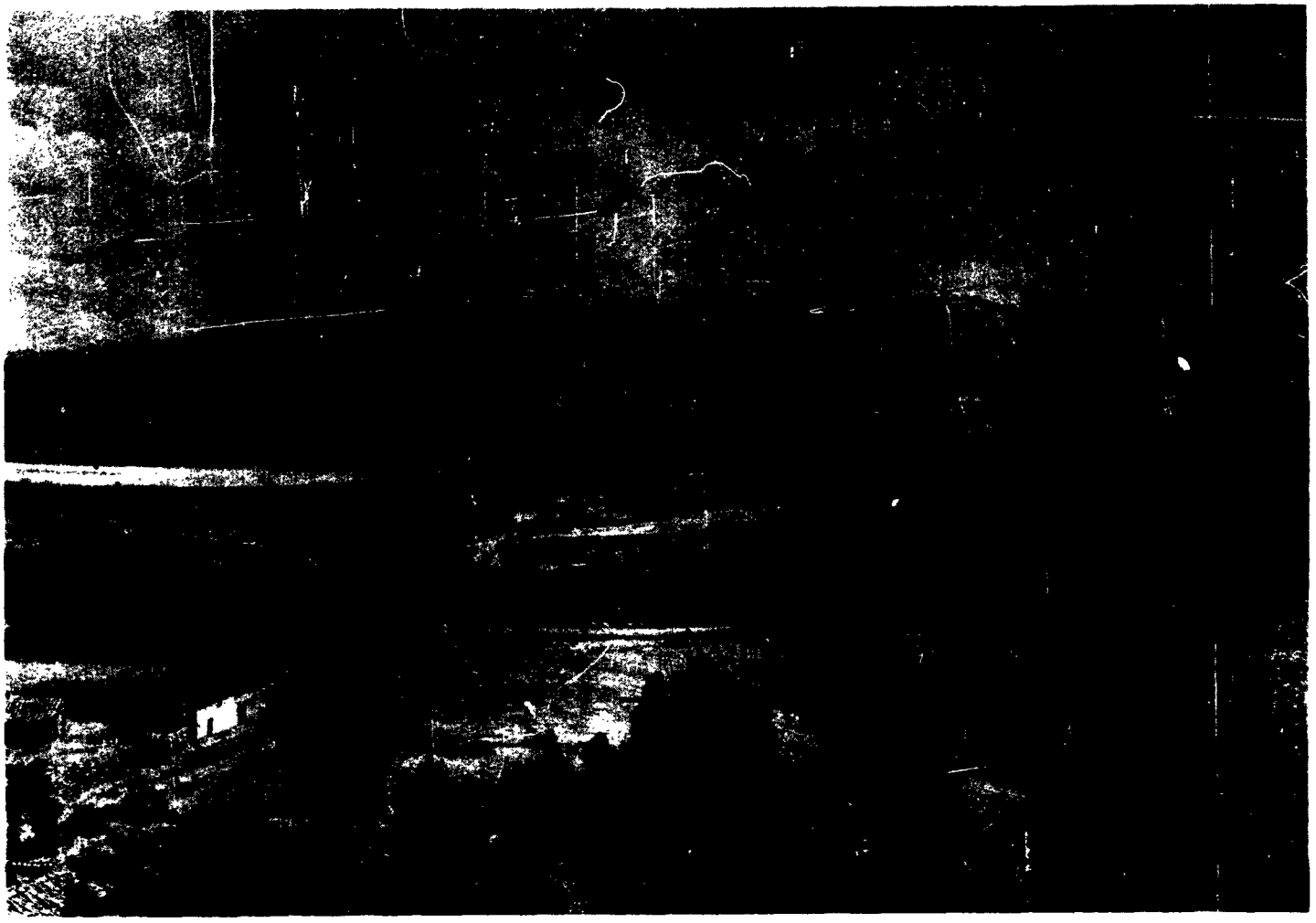


Figure 2 GENERAL VIEW OF CHINCHERO DISTRICT

Observations on the physical characteristics of these three groups suggest that admixture with Europeans has been insignificant and their genetic system is thus almost entirely native. Therefore, despite the class designations it appears reasonable to estimate that the genetic constitution of the people of Chinchero is from 95 to 99 percent derived from Quechua Indian.

Chinchero is located in the cold altiplano or highlands of Peru and from the arrival of the Spanish conquerors until the early 1900's this country was almost entirely grasslands containing no forests. It is believed that natural forests existed at one time in the past but that this forest had been completely destroyed by the time of Spanish arrival in the area. Beginning in 1900 there was the introduction of the eucalyptus trees and there are now small stands of eucalyptus distributed in the territory. However, the number of trees involved is still quite small. The country is, therefore, primarily a natural grassland which becomes green during the summer months (approximately from December through April) and is, for the rest of the year, dry and brown both from the cold and the lack of moisture.

Climate

The Chinchero area lies within the tropical zone and has very little seasonal variation in climate . Changes are primarily attributable to the alternation from rainy to dry season. The rainy season is considered to extend from January through March. However sporadic rains can occur at any time during the year and significant amounts of rainfall occur from November through the first of May. During the rainy season, cloud cover reduces the high degree of diurnal variation. Daytime temperatures are warmer but the sensation of warmth during the dry season is similar because of the high solar radiation during this season. Detailed weather data for this area is lacking. It was possible to obtain an 11 month record of weather in Chinchero from a weather station maintained by CRYF. CRYF in Chinchero is an agricultural station maintained by the central government. This weather data, presented in Table 1, indicates a cold climate in which temperatures near or at freezing occur practically every night during the year. Temperatures slightly below freezing occurred 8 months out of the 12 month period. Although June weather data is lacking these statements are warranted, since June is consistently the coldest month in this part of South America. The low nightly temperature makes agriculture marginal and requires that the crops grown be cold resistant. Actually a four month period from December through March occurred during which no temperature fell below freezing although temperatures fell to freezing. This weather data was collected at the lower limit of the major town of Chinchero. It is probable, therefore, that temperatures taken elsewhere may be slightly lower or slightly higher during minimums. However, maximum temperatures are not likely to have been affected to a substantial degree.

A high degree of diurnal variation is apparent from the weather data, with daytime temperatures throughout the year rising on the average to the upper 50's to lower 60's. The absolute maximum recorded

TABLE I

TEMPERATURES AT CHINCHERO

11 MONTH RECORD

Month	Year	Average Max.	Average Min.	7 AM	12 Noon	6 PM	Absolute Max.	Absolute Min.	% Days 0 or below
July	61			29.5	60.6	47.5	68.0	23.0	87 %
August	61			31.8	57.0	46.6	66.2	19.4	50.0 *
Sept.	61			40.5	60.4	47.5	66.2	28.4	3.3
October	61	61.0	30.4	43.2	62.8	48.6	66.2	28.4	40.0
November	61	60.4	33.3	45.7	57.9	47.1	64.4	28.4	26.3
December	61	67.3	33.8	45.7	60.8	47.5	73.4	32.0	30.0
January	62	67.5	33.8	46.2	61.7	47.8	77.0	32.0	33.3
February	62	67.5	33.4	45.0	61.5	47.3	75.2	32.0	36.7
March	62	63.1	35.2	45.9	59.4	46.6	69.8	32.0	3.3
April	62	63.1	33.6	44.2	60.1	48.6	68.0	26.6	33.3
May	62	64.2	35.2	45.1	60.3	48.7	68.0	21.2	80.0
AVERAGE		64.2	34.0	42.6	60.3	47.7	69.3	27.5	38.5

* Based on 7 AM, 12 Noon, and 6 PM record

during the 11 month data period was 25°C. or 77° F. However, this temperature was most unusual and during most of the year, the temperature failed to rise above 20° C. or 68° F. Of course, these maximum temperatures cannot be interpreted in the same way that they would in other environments since the tropical and high altitude location make solar radiation highly significant to both animal and plant life. Unfortunately, no data on solar radiation or percent of cloud cover are available for this area.

As can be seen from the weather summary this area would not be habitable by man without cultural protection and may be therefore considered a significant cold stress area for human habitation.

Culture History

Chinchero was chosen for study, in part, because of its known historic continuity of occupation. Based upon archaeological evidence and historic documentation, it is clear that Chinchero formed an important ceremonial center in the days of the Inca some 500 years ago. It is believed that an important palace of the Inca stood on the site of the present church, and this has sometimes been referred to as the summer palace of the Inca since chroniclers report that he often visited this area during the summer months of the year and spent significant time in residence. It also appeared to be somewhat of a model community under the Inca system since extensive terracing, which were presumed to form experimental or demonstration gardening areas, are found at the edge of the village. Based on the ruins which may be seen superficially, it appears that the population density 500 years ago was approximately the same as it is today. Actually, the central town contains the same basic streets of the Inca era. The majority of the houses are built upon stone foundations considered to be of Inca origin or earlier. The main plaza remains the same, containing the ceremonial wall that was in front of the Inca's palace. The major change in architecture probably lies in the greater use of adobe rather than stone construction for individual houses. Tile roofs have also become moderately common in the community as can be seen from Figure 3. The straw roof is traditional and was used on most of the houses in Inca times. However, there seems little reason to believe that basic house construction has changed significantly and temperature conditions in the houses have probably been consistant over the past 500 years.

Chinchero is an agricultural economy with herding as a subsidiary activity. It is basically similar to earlier forms, although the crops and animals have been influenced by importations from Europe. Traditiona agricultural crops were potatoes and quinoa (a type of grain). The potatoes remain a staple in the diet but quinoa has been generally abandoned in this area and at present wheat and rye are more common. Llamas and alpacas which were the basic domesticated animals in previous times have generally disappeared from this district and at present considerable numbers of sheep and some cattle are now being raised. Methods of cultivation are probably more traditional than the crops. At present cultivation is accomplished primarily with a foot plow and hoe The foot plow is a design of great antiquity, however, in the present day

Figure 3 THE TOWN OF CHINCHERO

form has an iron point while the earlier forms used wood. Only in the one hacienda in the district is any extensive use of the European oxen and wooden plow found, and no mechanized methods of agriculture are practic Export and import within the community remains at an extremely low level. Two small stores in the community sell a limited variety of food stuffs and there are no permanent stores selling material items such as clothing. The majority of the surplus grown is bartered or sold in the Cuzco market. The people from this area go by truck into Cuzco once or twice a week to trade. The truck comes from the Cuzco area, since there are no permanently maintained vehicles in the district. In addition there is a small Sunday market in the plaza of the central town. Except for the import of a few items of food and drink (primarily sugar cane whiskey) the consumables are locally produced. Western style clothing is also purchased but again the majority of clothing is locally produced including the weaving of cloth.

For purposes of this study it would appear that very few changes have occurred in the past 500 years which might affect adjustment to the climate. Among the possibilities which must be noted are the changes in the diet. In particular caloric intake may be lower at present than in the past. Another significant change may be the insulation provided by the clothing. Despite the fact that the majority wear traditional clothing, this clothing does not date back to Inca times but is generally derived from early Spanish costumes mixed with the native Indian costume. The introduction of shoes and sandals is quite a recent phenomenon and at all earlier times it is probable that the people were without any foot covering. Whether earlier clothing was heavier or lighter is somewhat difficult to judge but the fact that only llama and alpaca wool was locally available for clothing suggests that the clothing may have been slightly heavier than is used by some of the men today who are wearing cotton clothing.

Modern Material Culture in Relation to Cold Protection

During the months from May to September 1962, a number of houses in the Chinchero district were visited. These house visits involved noting of architectural features, household furnishings (with particular reference to heating facilities and bedding), typical clothing as well as interviews with persons of the household. In addition, sleeping patterns of families were noted on a number of nights and temperatures inside of dwellings were recorded on nine nights in eight different households. By observational methods, detailed descriptions of clothing were also made in order to determine their protective value. Data collected by these methods will be discussed under the categories of architectural construction of the house, actual degree of cold protection offered by the housing form and the protection offered by the clothing and bedding.

Architectural Features Houses in the district are generally constructed of adobe blocks with roofs of tile, or more commonly, of straw. The adobe blocks are made by mixing fine grained earth with water and straw. A mold is used to preserve a uniform size block. The blocks are about 50 to 55 cms. long, 25 to 30cms. wide and 15 to 20 cms. thick.

Occasionally a double wall of adobe blocks may be found in house construction but the majority of houses use only a single wall. The dimensions of the houses vary widely with family size, economic means and house functions. There is usually a household complex which includes in addition to the living quarters a small garden and perhaps a small field, a corral for livestock and, a small shed for pigs. The primary building is the kitchen-bedroom combination which is used as a living, eating, cooking and sleeping center. There is also frequently a building called a dispensa. This is a building of much the same dimensions as the kitchen-bedroom and is used to store goods from harvest and other items of daily use. The complex of buildings may be further augmented by buildings for storing fire wood or by the buildings of relatives who often reside in the same complex. In most cases, the dispensa is slightly larger than the kitchen-bedroom. In nearly all cases, the buildings have a single story. Notable exceptions are some of the buildings in the town proper. The larger dispensa may also be used as a bedroom when the families are large. Generally however, the living quarters coincide with the cooking quarters and may or may not be augmented by other buildings for food storage.

The size of a typical kitchen-bedroom combination averages 20 x 10 feet at the base with a height of 6 to 7 feet at the eaves. The peak of the roof is 9 to 10 feet above this level. In all cases the floor plan is rectangular with a single door located on the long side. The doors of the houses are quite small being about 20 inches wide and 36 inches high. The sill of the doorway is about one foot above ground level. The doors are generally of wood, either roughcut or of sticks. In some cases, the doors consist only of some skins over a crude wooden frame. Doors are not tight and considerable cold air enters the house in this manner. As the doors are located off-center on the long wall of the building, only one side of the house is most subject to a draft of cold air coming through this entrance. In nearly all cases, the kitchen is situated on the side with the door while the sleeping quarter is located in the opposite half.

Generally the houses are without windows, although there are two types of wall openings. The first, air holes, are located in the side walls of the building near the peak of the roof and are always above the level of the side walls. There is also at least one and sometimes more on each side of the wall. Second, viewing slits are located in the walls at about eye-level. In many cases they were present on only one or two walls, but they are sometimes found in all four walls. The openings are used to keep a watch on cattle, and other belongings which are kept outside. The openings vary in size and shape but are generally rectangular, about 9 inches high and 6 inches wide. Smaller openings are not closed at night but larger openings were closed, if only with paper, in order to prevent the entrance of cold air.

In some cases the walls of the building are not constructed entirely of adobe blocks but have a stone foundation upon which adobe is laid. The foundations in the town may be the remnants of old Inca house ruins. In one of the outlying allyus, Umasbamba, where rocks are plentiful, construction of house walls may be entirely of stone.

Average House Form

Cooking on the Fagon

The House Complex

Cholo and Indigena Attire

Figure 4 MATERIAL CULTURE PROTECTION FROM COLD

Roofs are generally of straw thatch which is laid over a frame of wood, often wild sugar cane or eucalyptus wood. Long beams in the roof frame extend the full length of the house and are tied down to the side walls by means of pegs which are inserted in the adobe in the external aspect of these walls. Vertical cross-beams are also used and they are secured by tying to the long horizontal beams. The thickness of the straw roof is about 10 inches. The inside of the roof is rapidly covered with soot and tars from the cooking fire which serves as a cohesive agent as well as closing off air space. When the house is complete large air spaces exist between the adobe blocks of the side walls and the roof. These spaces may be partially filled by pieces of adobe, bunches of straw, or adobe may be trimmed in order to make a tight weather proof fit with the roof.

No facilities are directly used by the Indigenas for the heating of their houses. All fires are limited to the cooking of foods on the stove or fogon which is located in the corner of the kitchen-dormitory building. The fogon complex is about three feet long, two feet wide and two feet high. It consists of a rectangular clay base about eight inches to one foot in height, above which a hollow clay stove is formed with openings on top shaped to hold jars and cooking bowls. In the vertical front side of the range there is an opening through which fuel may be fed. The openings in the top of the range and that of the side are irregularly formed and are approximately nine inches in diameter. The fogon complex may include a storage bin at one side for keeping fuel and perhaps a level surface nearby on which food can be placed prior to and after preparation. Fuel varies and includes dried eucalyptus leaves, dung of cattle and sheep, and eucalyptus or motoy branches. The fire of the fogon is used only for cooking and not directly for heating the quarters. Cooking is done immediately upon awakening in the morning and may involve two or three hours of preparation, as morning and midday meals are often prepared at the same time. Morning cooking takes place between the hours of five and eight A.M. Fire is also used for preparing the evening meal and may be kindled for one to three hours between four and seven P.M. During the harvest season, the midday meal may consist solely of a potato roast prepared and eaten in the fields. The morning cooking is thus reduced during this season. The period of harvest also conforms to the coldest period of the year.

House Temperatures Temperatures during the night were collected in several houses in the main village of Chinchero. Data on these temperatures is shown in Table 2. As can be seen, the construction of the house and the manner in which it is used provides a significant protection from the outdoor cold. A major part of this protection is offered in the early evening hours. A detailed examination of temperatures by the hour was made in three of the houses. This analysis revealed that the warm temperatures noted at 8:00 P.M. were maintained with a very slight drop for approximately two to three additional hours and then a rather sharp drop in temperature occured near the middle of the night. As can be seen from Table 2, the drop in temperature from midnight through 5:00 A.M. was very gradual. It thus appears that the house construction and use provides a considerable protection from the outside environment during the early evening and early night hours while it continues to provide protection against the minimums reached

TABLE 2

Temperature Modification obtained by House Construction

House	Inside Temperature at 40 cm level				Outside Temperature 8 PM - 6 AM
A	8 PM	12	5 AM	Absol. Min.	Absolute Minimum
Night 1	52.0	51.1	48.0	46.0	30.2
Night 2	53.1	48.0	45.9	45.0	28.4
B	-	-	-	44.1	28.4
C	64.0	-	45.9	44.1	28.4
D	55.9	48.9	44.1	44.1	35.6
E	54.0	49.0	43.0	43.0	35.6
F	50.0	49.1	44.6	44.6	39.2
G	53.6	50.4	50.0	50.0	42.8
H	57.9	-	-	45.0	26.6
Average	55.1	49.4	45.9	45.1	32.7

in the early morning hours, this protection is less effective than it is during the early evening. Such a pattern of temperatures might be anticipated from the heat holding capacity of the heavy adobe construction.

Protection from Nighttime Cold by Bedding and Clothing Beds are commonly found in the community of Chinchero and are nearly uniform in construction, consisting of a platform of eucalyptus branches supported at four corners by adobe blocks over which is placed a layer of reeds and straw. The beds are square or slightly rectangular and are large enough to accommodate at least two persons. They vary in height from 40 to 60 cms. above floor level. The layer of straw placed on the supporting poles is about two to four inches thick. Over this foundation a number of sheep hides are placed. The Indigenas generally sleep directly on these hides although a blanket may be used to cover the hides before lying down. The over bedding consists of whatever covers are available. The number of homemade blankets vary from two to five. In cases where a minimal number of blankets are available the women's shawls called llicklla or the carrying cloth, costal, are used as supplementary coverings. Indeed, almost any garment available may be used for a cover including the male outer garment of poncho.

The beds are generally located in a corner of the building on the opposite side from the fogon and doorway. Some individuals sleep on the floor but in most cases this method of sleeping is used only with very large families or in the case of guests who are living in the house. In this situation, sheep hides are put on the floor and sleepers cover themselves with the same blankets, costals, and llicklla. The raised platform for sleeping is apparently not a recent practice although the exact construction of the sleeping platform may be a modern innovation. Inca house construction shows evidence that a raised dirt or clay platform at one side of the house was used as a sleeping platform. Such platforms are still commonly encountered in the colder regions to the south of Chinchero in the department of Puno. In one of the ayllus, Umasbamba, and in some other outlying areas, the plan of sleeping on the floor is apparently more common than it is in the town of Chinchero. In these cases a quantity of straw is commonly kept in the house and at night it is spread about in a layer before the sheep hides are placed on top for sleeping.

In most cases it was observed and reported that some sort of clothing is worn in bed. It was reported that some people sleep nude but this appears to be a largely archaic practice and at present has disappeared. In Umasbamba and the other outlying communities the practice of sleeping nude is said to be more common than in the Chinchero community itself. Children, however, in all places commonly sleep without clothing at least until 10 to 15 years of age. Post-pubertal females commonly wear an inner skirt from the regular daytime garb. Generally the older females dress themselves in the innermost white skirt which is ordinarily worn under some of the outer skirts and they may in addition retain their inner skirt. The older males almost always wear their inner shirt and one of the pairs of pants that they wear during the day.

Figure 5 INDIGENA CLOTHING

Daytime Clothing Both men and women wear clothing which has developed from old Spanish styles and which have been influenced by contemporary trends of western culture. Thus, while men wear pants in all districts, far less machine produced pants are found in the outlying regions as compared with the town of Chinchero. In these outlying regions the traditional cut of pants is still used; that is, pants are tightly fit and reach only midway between the knee and the ankle. They are generally home made from wool. In the town, vestiges of this style are obvious in that the machine made long pants are worn rolled halfway up to the knee. Men have apparently been more subject to changes in traditional clothing and to acculturative influences in general than have women. For this reason women's dress is more nearly uniform, with modern influence seen only in the outfits of the Cholo and the Mestizo class women.

Women commonly wear skirts made from sheep wool and these skirts are now normally imported from other parts of Peru. They reach from the waist to the ankle level and several of them are worn at one time. An approximate average would be four skirts at a time although the number is variable. Women wear up to seven skirts and the high number of skirts seem to be worn either for a fiesta or during cold weather. A white inner skirt is worn under the outer layer of blue skirts. Above the waist, Indigena women wear a shirt made of cotton with long sleeves. Over this, on occasion, is worn a sleeveless white jacket sweater and on top of this heavy wool jacket. The jacket has long sleeves and is red in color decorated in traditional regional style. Over the top of the jacket a llicklla is worn. This is frequently used for carrying objects on the back. It may be replaced by the larger shawl, or costal for carrying larger objects. This shawl is also occasionally used to cover head, ears, and neck during very cold weather. The women also wear hats which are small circular ones woven of straw and covered with cloth. They wear a thin woven belt around the waist and on very rare occasions may wear the sandal made of tires which has been previously described.

The male as previously noted wears a pair of commerically made pants. These are of cotton and are similar to the khakis worn in the United States. However, occasionally, the traditional homespun material is made into men's pants. In such cases, the material is wool and they are considerably heavier. The pants are often ripped or torn in many places and most men wear two pair of pants at the same time to insure adequate covering and protection from the cold. At the bottom of the pants, the male wears a rubber circlet which is used to secure the end of the pants. These keep commercial pants midway up the calf and are reportedly used to prevent wear and tear on the bottom of the trouser leg On top the male wears a cotton shirt which is generally of commercial manufacture and over this a wool shirt. On top of the wool shirt, he wears a wool sweater and finally, as a top item a poncho is worn over the shoulders. There is great variation in size, shape, decoration and weight. It is worn during the day when temperatures are low. On the average the poncho is about 150 x 130 cms. and weighs approximately two kilos.

Almost all men wear a purchased hat similar to those worn in the United States. Under this hat, or perhaps in the place of it, he will often wear a woolen cap which has ear flaps that tie under the chin. Finally the male attire more commonly includes a rubber tire sandal. These may, also on occasion, be worn by young boys. The wearing of this sandal seems to have status connotations and this may be one of the explanations for its common use by males while it is not used by females.

Behavior Patterns in Relation to Cold Stress

Pattern During Waking Hours. The Chinchero native, as most agriculturist awakens at an early hour. The hour of awakening may be anywhere from 3:30 to 7:00 A.M. The most often reported hours for awakening are between 4 and 6 A.M. Observation in the house during the night indicated that the individuals normally remained in bed an additional half hour before arising. The woman generally arose first and immediately prepared a fire in the fogon for cooking breakfast. Once the fire was started and breakfast begun, the male and children of the household arose. Immediatel upon arising the person dressed fully and cleared away the sleeping covers. It is probably during this early morning period that the greatest cold stress was observed. Shivering was common and the family was sufficiently inactive so that total body chilling was common. After the completion of breakfast both men and women generally proceeded to the day's agricultural tasks. The fields are mostly located at a distanc from the house and the combination of metabolic activity from walking and the new rising temperature suggests that very little cold stress to the total body would be experienced after this time. However, it should be noted that the men and women are normally without shoes and without gloves. The ground is near freezing temperautre and, therefore, it may be anticipated that both hands and feet are exposed to cold stress, although the central core of the body probably is not. Observations were not made during the rainy season and it is possible that considerabl cold exposure occurs during the rain.

During the day no significant cold stress normally exists and the next period during which the cold stress might be significant is in the evening hours. The groups appear to go to bed quite early after nightfal between the hours of 7:00 and 9:00 P.M. Observations on behavior in various households showed that it was quite common for the household group to retire but not go to sleep immediately. Instead, they would stay awake and talk for extended periods of time. This suggests that the bed provides a significant protection against cold and is used even though the population may not be ready to go to sleep.

Sleeping Behavior. The modal behavior is for at least two persons to sleep together in a single bed. The husband and wife usually sleep together and children until five to ten years of age may accompany them. Children of all ages, male and female, sleep together and thus there may be three or four children in a single bed. In cases where the husband is absent, one or more children may sleep with the mother. It is well recognized in the community that it is warmer to sleep

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together than to spend the night alone in bed. It is, therefore, always the preferred practice. The sleeping posture is nearly the same regardless of age or sex and reports are uniform in agreeing on the sleeping position. They generally sleep with their knees tightly flexed. Generally this is accomplished by sleeping on the side, but even at times when the persons were observed to turn on their backs while sleeping the knees were still bent and kept upright. The blankets were kept on at all times and much of the time the face was also covered by blankets. A description of the behavior pattern during the night in several families observed will suggest the general pattern of nighttime behavior and some of the variability relevant to cold protection.

One family observed, consisted of a husband and wife and six female children, ranging in age from one to sixteen. The married couple and the three youngest children slept on the conventional bed-platform. The older three girls slept on the floor using pelts as bedding. The bed platform was built from branches and reeds from the nearby lake. About six pelts were placed over the reeds as underbedding and one blanket was used as overbedding. Llicklas and ponchos were used to augment the blanket. The bed was about 50 cms high and was located on the opposite side of the house from the fogon. The house itself was about 15 feet long and 9 feet wide with walls of adobe and a roof of straw. The door was only a framework of sticks and afforded little protection from the cold of the night except that its dimensions were small. On the night of the observation, [illegible] two youngest children, slept in the house in the bed with their parents. Two of the girls slept in the adjacent dispensa, while the two others had left to stay with relatives. The family went to bed about 8:30 P.M. At the time, the house was still somewhat warm from the fogon fire which had been burning previously for the cooking of supper. The family slept soundly throughout the night, a slightly curled position was used while sleeping on the side. As one daughter slept along the foot of the bed, it is difficult in this case to say whether the flexed position was normal or due to cramping in the sleeping area. The family woke about 5:15 A.M. and dressed. The door was opened and the fire was started. The girls from the dispensa entered the house and helped with the fire and the food preparation. The husband fed the livestock and took care of some minor chores.

In another family the situation differed somewhat from this example The house was part of a complex in which an extended family lived. Part of the family slept in the kitchen while the others slept in the dispensa. The observations here pertained to the kitchen group. Sleeping was done directly on pelts placed on the dirt floor of the building. Only a blanket and poncho were used as covering. The group went to bed about 8:00 P.M. at which time the fire in the fogon was still burning and the room was warm. There was very little talking or restlessness throughout the night on the part of the sleepers. A side position for sleeping was used and the knees were flexed even when the individuals turned on their backs. The group awoke at 5:30 A.M, and dressed, after which the woman started the fire.

In the adjacent building, sleeping behavior differed. The building was larger, contained no fogon and was consequently colder than the kitchen. The group wore undergarments and shirts to bed, and sleeping behavior was varied. The occupants awoke several times during

the night and held discussions lasting up to a half hour. The sleeping positions varied, starting from a prone position while awake but ended in a flexed position while sleeping. In one final example, the inhabitants, an old woman and her son, 12 years old, slept on the floor in the kitchen. Bedtime was at 7:30 P.M. although there was still activity in the adjacent room occupied by other members of the family. Both mother and son slept quitely although the woman moaned occasionally. A side position was used by both persons. Initially the knees were not flexed but later during the night they were. The mother was wearing the inner white garment and a skirt. The son wore an inner shirt and was nude from the waist down. The pair woke about 6 A.M. but remained in bed for a while. The woman, then rose and dressed while her son remained in bed. The son arose about 15 munutes after the fire had been lit.

Summary of Cultural Adaptations to Cold in Chinchero

The cool days and even colder nights of the Sierra provide the possibility that the indigenous population would be subject to significant cold exposure. However, a number of cultural elements help to moderate and determine the nature of this cold exposure. Behavior patterns, clothing, shelter and heating are some of these cultures elements. Behavior of the people in Chinchero is closely allied to the sun cycle. The hour of sleep is at sunset and the hour of awakening is shortly after sunrise. During the cold night, shelter is taken in the adobe houses. The houses are cool during the night despite the effect of cooking fires but the micro-climate of the individual is modified by the use of blankets, group sleeping and heat-conserving sleeping positions. Little discomfort due to night cold is apparent. Most of the waking hours are spent in agricultural or pastoral activities and these activities are outdoor ones. These normal daily activity patterns substantially raise heat production over basal rates and combined with the insulation provided by the heavy clothing worn, act to prevent chronic total cold stress during the day. The face, hands and feet are apparently the body areas most directly exposed to cold because these areas are not covered by garments. The actual degree of possibile micro-cold stress cannot be determined accurately without core and skin temperatures of the natives during their normal activity. On the basis of the data collected, it is suggested that the total body cold experienced by the individuals in this community is not of very long duration nor of very intense nature. Such exposure as does occur will probably primarily effect the hands, face, and feet with only a secondary overall cold stress. Of course, the data collected concerns the normal cultural situation and it may be anticipated that all individuals living in this culture are at sometines during their lives exposed to a considerably greater micro-cold stress than is apparent from these observations.

CAMICACHI

To check the validity of the cultural adaptations to cold found in Chinchero an alternative community with slightly different historical and cultural background was investigated. The community chosen for this comparison is named Camicachi. Camicachi is a community in the Department of Puno, lying about seven miles west of Ilave and 40 miles by road southwest of the Department capital, Puno. Unlike Chinchero, Camicachi does not form a political district. It is instead a diffuse community lying on a plain adjacent to Lake Titicaca. The settlement pattern is one of sparse house complexes spread over approximately 25 square miles. This community is 10 miles to the west of the shores of Lake Titicaca and the land is only a few feet above the level of the lake. The communi is approximately the same altitude as the town of Chinchero.

However, weather conditions appear to be considerably different from Chinchero. The more southern location and the proximity of the larg lake make for a greater amount of precipitation and more marked seasonal changes in temperature. The location of the community in relation to the lake also makes it subject to a constant wind blowing in from this direction. Wind velocity during the time the community was studied in late August and early September ranged from about 5 to 15 miles per hour, but informants stated that the velocity increased considerably during the winter. In general, the weather pattern is typical of the highlands with a summer rainy season and a long winter. It appears that there is some precipitation at all times of the year in this area. Snows to a depth of nearly five feet were reported but this seemed to be an exceptional circumstance. During the two weeks of observation practically all types of precipitation were observed with rain, sleet, hail and snow, along with below freezing temperatures most nights.

This area of Peru is covered with short Puno grass and is completely lacking in trees. Eucalyptus will not grow in the region and in general no other variety of tree is found. In the hills a considerable distance from the community, small brushy trees are found which are used for house construction but scarcity and difficulty of transportation prevents their use as fuel. The extended community of Camicachi probably contains more than 5,000 people. The people make their living almost entirely through agriculture. No significant commerical enterprise was found. Surplus crops were taken into the town of Ilave or into Puno for trading and as in Chinchero the community seems to be primarily self sufficient. However, there were signs that this community has gone through more acculturation and was more westernized than the community of Chinchero. For example, the foot plow method of turning over the ground had been replaced by the use of oxen and the Spanish wooden plow. Several tractors were found in the district. These were a recent introduction and probably the by-product of attempts to improve the agricultural production of the area by outside government agencies.

The people occupying this area are Aymara speakers. This group has a slightly different cultural history than the Quechua speakers of the rest of the highlands of Peru and are restricted to the region around Lake Titicaca. No historic or archaeological information concerning the specific history or pre-history of this town was available,

but it appears to be an area of continuous habitation and from general descriptions ofAymara culture and archaeology it may be assumed that this community has had a long continuity of fairly similar culture form. The most important modifications for the purpose of this study which have been introduced by western culture are changes in dress and the use of tin for roofing in some of the houses.

Material Culture in Relation to Cold Protection.

As stated previously the observation periods and methods were shorter and more superficial for this community than were used in Chinchero. Observation was continued over only a two week period of time. The house construction in this area is very similar to that found in Chinchero, and unless noted other wise in this report the details may be assumed to be the same. One of the differences noted was the common use of sod blocks rather than adobe blocks for construction. When available the sod was cut directly into blocks of a size comparable to the adobe blocks in Chinchero, and the house was constructed of this material. Sod blocks were considered more desirable than adobe blocks since it was claimed that they resisted washing away from rains more completely than did the adobe. When adobe was used, it was made in the same manner as noted for Chinchero.

House complexes consisted typically of at least two buildings surrounded by a wall. Two basic sizes of houses were constructed. The smaller one was much more common and was used for the kitchen. This smaller house measured 9 x 16 feet on the outside and has walls about 8 feet high, with the peak extending some seven feet above wall height. The larger house was similar in width and height but had a long wall of about twenty feet instead of sixteen feet. Doors were located off center on the long walls as reported in Chinchero and were of the same small 20 x 36 inch size.

Doors to fit the door openings were generally made of cut lumber and were of very tight construction. Camicachi houses had more windows than were found in Chinchero and frequently glass was used. In houses where the people did not have glass, the openings were small and filled with blocks so that the exterior opening was quite small. The number of windows per house varied considerably, depending apparently on the builder's ability to obtain glass. In houses where glass was lacking, as few as two filled holes served as windows and most of these were located near the roof peak. Roofs were in general made of grass, but were much thicker than in Chinchero. In a small percentage of houses, tin roofs were used. It was not possible to observe whether insulation was used under the tin. However, in contrast with Chinchero, roof and wall joints were carefully filled with adobe so that there were no air spaces.

House Furnishings. At the opposite end of the kitchen from the door opening there was a bed or sleeping platform. This platform extended from one wall to the other and was about five feet wide, at a height of 18 to 24 inches from the floor. In each kitchen observed the bed was covered with bedding material although native informants said these beds were seldon used. The wall opposite the bed contained the stove. Three varieities of stoves were observed. The first was built like a bee hive,

constructed on a platform, with two holes in the top for cooking. It did not have a chimney and vented directly into the house. This form of stove is almost identical with the common type found in Chinchero. The second type was similar to the first except that it contained a chimney which vented to the outside through the wall. A third type was constructed on a platform outside of the house. It was 8 feet in height with a chimney extending above that. The entrance to this large stove opened into the house through three foot square opening. Informants said this type of stove was used exclusively for bread baking but it appeared to be quite frequent. All of the stoves burned horse, sheep and/or cattle dung which was stored near the stove in small quantities.

The interior of the dormitory was similar to the kitchen except there were two beds, one at either end and there was no stove. All dormitories had one or more windows while windows in the kitchen were rare. Sleeping platforms were made of adobe and were covered with hides in a fashion similar to that found in Chinchero. The occupants when sleeping on these platforms generally covered themselves with blankets and did not usually use ponchos and other odd items of clothing such as was observed in Chinchero.

Obersvation on Temperatures Inside of the House during the Cold Night Period. Two kitchens were measured for temperatures during the night and it was found that they had quite high temperatures during the early evening period, the one reached a temperature of 72°F. and the other 82°F. However, both fell quite low during the night, the one to 37° and the other to 28°F. Observations made in three dormitories indicated early evening temperatures which were quite warm, in the 60's, with the early morning temperatures again falling to between 30° and 50° F. No specific data on nighttime temperatures outside the houses available, but observations made in early morning and late evening hours indicated air temperatures slightly below those observed during the time of house temperature measurement in Chinchero. From this data, it is apparent that the Camicachi house is more tightly sealed and nighttime temperatures do not appear to fall as low as they do in the Chinchero houses.

Clothing. As in Chinchero the men generally wore the Western style of clothing with one addition. They almost always wore full length homespun underwear made of cotton or wool. The undershirt had either long or short sleeves but the pants were always of ankle length. Men also wore shoes and occasionally stockings much more commonly than they did in Chinchero. Indeed, they wore shoes all the time except for the periods when they were actually working in the fields. During work in the fields they would go barefooted. Also if the ground was quite muddy they would remove their shoes and go through the mud barefoot. Again the impression is that shoes are worn primarily for status although their constant use among males here suggests they may have some function as protection against the cold. The women dressed very similarly to women in Chinchero. No tabulation of the number of skirts and blouses was possible in this area. As in Chinchero, the women did not wear shoes and walked barefooted all the time. While sleeping, this group of people seemed to wear clothing universally and there were no reports of sleeping nude. Even children apparently wore clothing to bed more frequently than was reported for Chinchero.

Behavior Patterns in Relation to Cold

The daily behavior cycle in Camicachi appears to be almost identica to that found in Chinchero, the people rising early, the woman preparing the fire and the rest of the family then arising. They go to the field early in the morning and generally spend most of the time outside of the house until night. At night they retire early and spend the night in bed. In observing this village it appeared that fewer people were outside of the houses at night than in Chinchero. However because of the short observation period it cannot be stated conclusively that this was the case. The practice of sleeping in groups in the beds and assuming the flexed sleeping pattern is also common in this area.

Summary of Data on Cultural Adaptation to Cold in Camicachi

In the Camicachi area it would appear that primarily because of the greater precipitation and the greater annual variation in the temperature, the external environmental cold stress is somewhat greater than it is in the Chinchero district. However, the people of this area are somewhat wealthier and seem to provide themselves with a greater amount of cultural protection against cold. This is shown by the tighter construction of the houses with resulting higher temperatures within, by the greater amount of clothing worn by the men as well as the frequent use of shoes by the men. This does not mean that they may not occasionally be exposed to cold stresses greater than that encountered in Chinchero, but on the basis of this short observational study it would appear that the people of this area use the same cultural mechanisms for adapting to and protecting themselves from the cold environment but use the methods more efficiently and more intensively. The greater cultural protection may either be because of greater wealth or the greater amount of cold stress encountered.

BIOLOGICAL ADAPTATION TO COLD

A survey of the climatic conditions encountered in Chinchero has indicated that significant cold stress exists in the environment. The study of cultural adaptations to cold have disclosed several methods whereby the actual micro-environment cold stress is reduced in this culture. However, these studies also suggest that, at least by modern Western standards, this culture does not completely accommodate to the cold stress and the micro-environment of the people indicates that they live in significant cold stress. Whether this cold stress would be significant enough to produce genetic selection is not clear but it would certainly produce acute discomfort and the exposure of the extremities to very low temperatures suggeststhe possibility of actual genetic selection being manifest. The study, therefore, suggests that biological accommodation to cold may be present as well as cultural accommodation. A series of biological studies were, therefore, designed to determine whether there existed acclimatization and/or genetic adaptation to cold.

Research Design

Three types of data were collected in order to evaluate the possibility of biological adaptation to cold. The first was anthropometric and body compositional data which would indicate the presence of any anatomical adaptations to the cold. The second, was physiological data collected during exposure to moderate total body cooling. This study was designed so as to expose the group to a cold stress that would be relaistic in terms of their everyday experience with total body cooling. The third was data from a study of the thermal responses of the hand when exposed to extreme cold. The technique used in this study of immersing the fingers in ice water for an hour period probably produced a greater cold stress than the people generally encountered in their environment. However the choice of this research procedure was dictated by the lack of adequate technical tools to accomplish a more realistic cold exposure.

Since no comparative standards for responses in the cold exposure tests have been published it was necessary to design studies which incorporate controls or reference groups. To obtain the maximum information from available populations, four groups were studied. These were: (1) adult Chinchero Indigenas, (2) Indians from the Altiplano who were at the time students at the University of Cuzco, (3) native Peruvian Whites (European descent) who were also students at the University of Cuzco, and (4) a small group of U. S. Whites who had been in the Altiplano for three to six months. The choice of these four groups was made in order to encompass both genetic differences, that is, the differences between Whites and native Indians, and environmental differences, i.e. the difference between student populations from the higher social classes and Indigenas. The choice of these populations permits at least a partial differentiation between genetic and acclimatizational factors in any difference encountered. Anthropometric data and total body cooling data was obtained for all four groups. However, hand cooling data was not collected on the U. S. White group in the Highlands. Instead, in order to provide a more adequate sample,

Hand cooling data was collected in the United States on a group of U.S. university students. This data has not yet been analyzed and will, therefore, not be included in this report. The general research design as outlined also permits an evaluation of the relationship between the anthropometric data and the physiological responses to cold. However, analysis of this part of the study is not yet complete and a report on this aspect will also be deferred until the final report.

Methods

Body Structure. Standard anthropometrics such as age, height, sitting height and weight were collected by conventional methods. In addition a questionnaire was administered to determine lenght of residence in the highlands, parentage and general health history. Specialized data was collected concerning body composition and skin color. Body composition estimates were made by use of the skinfold measurement technique. Skinfolds were measured with the Lange caliper which has a pressure of 10 grams per square millimeter of contact surface area. Skin fold measurements were made at six locations.

1. Forearm - in line with the arm just below the olecranon fossa.
2. Arm - posterior aspect midway between acromion and the olecranon process.
3. Chest 1 - Juxta nipple - with the caliper in line with the anterior of the axilla.
4. Chest 2 - on the mid-axillary line at the level of the ziphoid process
5. Back - at a point over the inferior angle of the scapula.
6. Leg - just below the popliteal fossa.

From three of these skinfold measurements, arm, chest 1 and chest 2, total body fat was estimated using the regression equation described by Pascale et al. (1956).* Fat free weight was calculated by determining the weight of fat from percent of fat and subtracting this from total body weight.

Skin Color - skin color measurements were made with the Photovolt reflectometer. Measurements of skin color were made at three sites. On the forehead, at the position of glabella, on the back over the inferior point of the scapula, and on the inner part of the arm. A total of six filters were used for each location to determine light reflectance in different parts of the spectrum. The filters used were the pure red, pure green, pure blue, the tristimulus amber, tristimulus green, and tristimulus blue. All of these filters were obtained through the Photovolt Corporation.

Because social class and racial designation are the same in Peruvian society, and because of the great antiquity of population admixture in the Highlands, it was necessary to segregate White and Indian students partially on the basis of anthropometric and anthroposcopic techniques. This was accomplished by use of skin color, hair form, hair distribution and facial characteristics. These techniques

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* Pascale, L. R., M. I. Grossman, H. S. Sloane, and T. Frankel 1956 Correlations between skinfolds and body density in 88 soldiers. Hum. Biol. 28:165-176

are subject to substantial error and while the student group called Indian in this study probably has very little White admixture, the group called White certainly does contain individuals with significant Indian admixture. Native Peruvians without Indian admixture are extremely rare in all parts of the Altiplano.

Total Body Cooling Study. Five U. S. Whites, 12 Indian students, 12 White students, and 24 Chinchero Indians were used to study total body cooling. Each of these groups was first dressed in a skin temperature harness which contained 11 thermocouples located in such a manner as to sample total skin temperatures. The exact location of these thermocouples and the general method is described in Baker and Daniels (1956)*. A measure of mean weighted skin temperature was obtained by weighting the individual skin temperatures according to the percent of the body surface sampled. Details of calculation are given in Baker and Daniels (1956). A rectal catheter with a thermistor temperature sensing device was inserted approximately five inches into the rectum and worn during the entire cold study. The men were then placed, dressed in shorts only, upon a canvas cot in a cold room for a two hour period. Skin and rectal temperatures were recorded at each 20 minute interval. The room in which dressing took place was maintained at a temperature of approximately 18° C. but considerable fluctuation in room temperature occured. The men were dressed in thermocouple harnesses as rapidly as possible and were then covered by blankets so as to precent body cooling until such time as they individually started on the cooling study.

Since a controlled temperature room was not available for the cooling study, a large room measuring approximately 23 x 28 feet was used for the cooling exposure. Windows in the room were blocked up so that sunlight could not enter. The room was constructed with thick adobe walls and an insulated ceiling. Since the daily variation in temperature was quite slight in this climate, it was possible to obtain almost exact day to day repitition of temperature conditions in this room. Exact data showing room temperature and humidity conditions are shown in Table 3. Wind velocity in the room was essentially zero. Six individuals were measured at one time and all individuals duplicated the cold exposure. The first and second exposures were compared to determine the reliability of the body temperature measurements and results wil be presented. For the comparison of groups, the average of the individua measurements obtained on the two cold exposures were used.

Finger Exposure to Cold. Twenty-six White students, 23 Indian students, and 33 native Chinchero Indians were studied for finger temperature responses to extreme cold. The studies were done at two locations, the students were studied at the University of Cuzco and the villagers were studied in a building in Chinchero. In both location subjects placed their right hand fingers, thumb excluded, in ice water to a depth between the first and second joint of the phalanges. The temperature on the palmar surface of the tip of the middle finger was measured using a tissue implant thermistor probe, manufactured by the Yellow Springs Instrument Company. The thermistor was held in place by placing the finger from a surgeon's glove over the middle finger. This

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* Baker, P. T. and F. Daniels Jr. 1956. Relationship Between Skinfold Thickness and Body Cooling for Two Hours at 15 ° C. J. Applied Physiol. 9:409-416

TABLE 3

Body Cooling Study: Room Temperatures

Study Time		N=8 Cuzco Students Dry Bulb	Wet Bulb	N=2 U. S. White Dry Bulb	Wet Bulb	N=8 Chinchero Indians Dry Bulb	Wet Bulb
Beginning	$\bar{x}$	53.87°F	47.85°F	53.50°F	48.0°F	56.0°F	47.50°F
	σ	2.1	1.7	-	-	1.0	1.7
20 minute	$\bar{x}$	55.88	49.00	54.50	49.00	57.25	47.87
	σ	1.2	1.8	-	-	1.41	3.0
40 minute	$\bar{x}$	56.88	49.71	55.00	51.00	57.88	48.25
	σ	1.02	1.4	-	-	.7	2.1
60 minute	$\bar{x}$	58.13	50.29	56.50	54.00	58.63	48.75
	σ	1.00	1.10	-	-	.77	1.1
80 minute	$\bar{x}$	59.38	50.00	58.50	54.00	58.88	48.86
	σ	1.2	1.3	-	-	.62	1.5
100 minute	$\bar{x}$	59.88	50.86	59.0	55.0	59.25	49.25
	σ	1.40	.64	-	-	.90	1.5
120 minute	$\bar{x}$	59.38	51.00	60.0	52.5	59.63	49.88
	σ	1.2	1.1	-	-	1.2	1.6
Average		57.63	49.82	56.71	51.93	58.23	48.62

method provided minimal insulation. Temperature was measured on an automatic scanning telethermometer and recorded on permanent tape. Readings were made both visually and automatically. Temperature of the finger tip was recorded each three minutes for a total of a one hour period. Figure 6 shows the general method and instrumentation. No duplicate exposures were made for this study.

During the test period the subjects wore sufficient clothing so that they were not aware of being cold. Room temperatures, however, were lower than would normally be encountered in the United States and were approximately 16 to 18° C. No visable signs of the subject's reacting to total body cold were observed. However, it is possible that some degree of general peripheral vaso-constriction was induced by the ambient air conditions. Among student groups, Whites and Indians were mixed during the time of actual measurements so that ambient conditions were comparable. It remains possible that testing in the Chinchero village may have been done under slightly different ambient conditions than those in which the students were studied. Water temperatures in which the students were studied. Water temperatures in which the fingers were immersed was maintained between 0 and 1 1/2° C. by placing ice in the water bath and stirring the water with a continuous stirring device.

Figure 6 ICE-WATER IMMERSION OF THE FINGERS

The temperature responses of the fingers in ice water form a series of very complex cycles. In order to evaluate all aspects of this response seven different indices of response were used. These seven include all of the indices which have been reported by previous investigators of this response.
The seven are:

1. Time to initial temperature rise - a measurement of time from finger immersion to the onset of first rewarming.
2. Temperature before first rewarming - the minimum temperature just prior to the initial rewarming.
3. Amplitude of reaction - difference in temperature between the minimum and maximum finger temperature after initial drop.
4. Maximum finger temperature - maximum after initial drop.
5. Minimum finger temperature - minimum temperature after immersion.
6. Mean temperature 5 to 30 minutes.
7. Mean temperature 30 to 60 minutes.

Results

Body Structure. Table 4 shows the anthropometric data collected on the Peruvian Highland groups and U. S. Whites used in this study. This table is based upon the total sample measured and includes subjects used for the physiological cooling studies. In total body weight, the four groups are quite similar to each other, but standing heights and sitting heights vary significantly. The student groups are taller than either of the Indigena groups and it would appear that the Aymara are slightly taller than the Chinchero natives. Whether these differences may be referred entirely to growth variation produced by environment or reflect a genetic phenomon is not clear. In skin color, the White student group is, of course, significantly lighter than either of the other groups but among the three Indian groups, it would appear that the student group is slightly lighter than the two native groups. Whether this is due to a greater amount of European admixture which could not be detected by the methods used or whether it represents a difference in amount of exposure to tanning, cannot be said with certainty. All four groups of native Peruvians are lower in body fat than the general average reported in the United States using the same methodology. The small differences between the groups show a slightly greater amount of fat in the student population than in the native population. The difference between the Chinchero and Aymara group is probably not of any statisitcal or biological significance. Differences in fat free weight although not great in the four groups show the Chinchero Indian to be significantly less muscular than either the student or Aymara populations.

Total Body Cooling Study. To test the utility of the skin and rectal temperature data for analysis of group differences, the data were subjected to tests of reliability and reproducibility. This was done by comparing the data from the first exposure to cold with the data from the second exposure to cold. Individual data from all groups

TABLE 4

BIOLOGICAL MEASUREMENT DATA ON MALES
HIGHLAND PERUVIAN GROUPS AND U. S. WHITES

Measurement	Cuzco White Students		Cuzco Indian Students		Chinchero Indians		Aymara Indians		U.S. Whites	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
No. of Sample	53		66		33		28		5	
Age	20.0	2.6	20.6	2.4	35.6	17.6	27.4	9.4	27.3	5.0
Standing Ht.(mm)	1668.5	50.0	1649.2	63.6	1555.6	42.2	1599.9	38.6	1761.0	26.1
Sitting Ht. (mm)	885.5	29.0	882.8	30.3	833.7	29.7	872.4	22.5	931.2	13.0
Weight (Kg.)	59.1	5.8	59.2	6.3	55.9	4.2	59.6	4.9	69.3	5.9
Skin Color										
Glabella Red	48.1	4.1	40.8	3.8	38.7	4.3	37.1	3.4	50.3	5.4
Glabella Blue	18.6	2.8	14.1	2.0	13.3	2.3	12.2	1.7	19.5	3.6
Glabella Green	18.3	3.1	13.9	2.2	12.8	2.2	11.8	2.2	19.5	3.6
Glabella T. Amber	29.1	3.5	22.8	3.3	21.3	2.8	19.7	3.3	31.0	4.1
Glabella T. Blue	14.2	2.6	10.1	2.1	9.0	1.7	7.8	1.5	14.7	3.9
Glabella T. Green	22.8	3.0	17.4	2.7	16.5	2.5	15.2	2.2	23.6	3.4
Arm Red	55.9	3.2	50.3	3.4	43.2	4.6	42.8	3.5	57.4	6.2
Arm Blue	28.1	3.4	21.7	2.8	16.9	3.1	16.7	3.4	30.8	8.4
Arm Green	29.9	4.1	23.3	3.2	18.2	3.9	16.9	3.3	32.9	8.8
Arm T. Amber	39.7	4.2	33.3	3.5	26.6	4.4	25.7	3.5	41.6	8.0
Arm T. Blue	23.3	3.8	16.7	2.6	11.8	2.7	11.2	1.9	26.0	8.7
Arm T. Green	33.8	3.8	27.5	2.0	21.5	4.0	20.2	3.5	36.6	8.3
Back Red	55.4	4.8	46.7	4.3	44.5	5.4	40.6	4.1	55.2	7.5
Back Blue	24.1	4.4	17.4	3.1	17.3	2.7	13.9	2.9	25.0	4.1
Back Green	26.2	5.4	18.3	3.5	18.0	3.5	13.9	3.0	23.9	6.4
Back T. Amber	37.2	5.2	28.1	4.0	27.6	3.8	22.4	4.7	37.4	8.7
Back T. Blue	18.6	4.3	12.5	2.7	11.8	2.4	8.7	2.3	19.7	6.7
Back T. Green	30.4	4.8	22.3	3.7	22.2	3.7	17.8	3.1	30.6	7.2
Body Composition										
Skin Fold Forearm	4.6	1.5	4.4	1.2	3.3	1.0	3.9	1.0	5.1	1.3
Skin Fold Arm	7.1	2.7	7.0	2.5	4.5	1.6	5.9	2.0	12.3	4.7

TABLE 4 - continued

Measurement	Cuzco White Students		Cuzco Indian Students		Chinchero Indians		Aymara Indians		U.S. Whites	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Skin Fold Chest I	6.1	3.0	6.7	2.8	5.4	2.1	4.8	2.9	8.5	2.8
Skin Fold Chest II	6.2	3.0	6.4	2.2	5.3	1.7	5.5	2.0	7.7	3.3
Skin Fold Scapula	9.4	3.0	9.5	2.3	8.2	2.2	8.0	2.2	10.1	5.8
Skin Fold Leg	9.1	3.4	9.7	3.3	5.4	2.1	6.6	1.8	10.1	0.9
% Fat	8.7	1.7	8.9	1.4	7.8	1.0	8.1	1.2	10.5	2.0
Wt. of Fat	5.2	1.4	5.3	1.2	4.3	0.7	9.5	1.7	7.3	1.9
Fat Free Wt.	53.9	4.9	53.9	5.6	51.5	3.9	54.7	4.4	62.0	4.2
Sum of Skin Fold	42.4	14.6	43.7	11.7	32.1	8.9	39.7	9.6	53.8	13.7

T. = tristimulus

Skin Color in percent of reflectance

were combined for this purpose. The resulting data are presented in Appendix A. It can be seen that there was no systematic difference between the tests and retest results. It was, therefore, considered valid to obtain an average of the two readings for greater reliability on temperature data. However, a correlation with second run data showed a low reproducibility. These coefficients seem rather low considering the biological nature of the data, but the possibilities of body movements during actual cold exposure may offer a partial explanation. They of course do not, suggest that the data have no inherent value as a measure of body temperature conditions. The data on the toe, hand, rectal temperature and mean weighted temperature show a higher degree of reproducibility than do the other skin temperatures. Because rectal and mean weighted skin temperatures represent total body cooling response the higher reliability might be anticipated. The reasons for toe and hand showing greater reproducibility than the other measurements is not clear. However, the high standard deviations for these measurements compared with other skin temperatures suggest that they may be more subject to individual constitutional factors. A detailed analysis of the difference between the four groups in mean weighted skin and rectal temperature during the cooling period is presented in Table 5. The difference between the groups were tested by the standard t test for uncorrelated samples and the results are presented in the same table. Some of the particular differences in skin temperature between groups may in part be the product of different behavior. A limited amount of body movement was permitted the group and, for example, some of the differences between skin temperatures on the inner thigh may be related to the fact that the students and more particularly the U. S. Whites in the study were observed to move their legs more than the native Chinchero Indians. However, the pattern of significant differences suggests a great deal more than simple body movement or cultural-differenc explanations.

The U. S. group stayed significantly warmer throughout the test period than the other three groups as measured by rectal temperature. Second to the American group in internal body temperature was the native Chinchero group. During most of the test period their rectal temperatures were higher than the two student groups and only at the very end of the test period did the significance of the difference decrease to less than the .05 level. In mean weighted skin temperature, the U. S. group had the lowest skin temperature during the entire exposure and this difference from other groups was consistently statistically significant at the .05 level or better. The Chinchero group began the test period significantly warmer in skin temperature than any other group. They remained throughout the test period highest in mean weighted skin temperature, although the difference is not statistically significant in later periods of the tests.

When the individual temperatures which go into calculating mean weighted skin temperature are analyzed (see Appendix B), it appears that the Chinchero group is higher in skin temperature because of higher temperatures in the body periphery. In particular the toe and hand temperatures remain significantly higher during the entire test period. Calf, thigh, forehead, and forearm temperatures also tend to remain significantly higher in the Chinchero group although there are

TABLE 5

GROUP DATA ON TOTAL BODY COOLING

Rectal Temperature

Group	Mean	S.D.	t Cuzco White St.	t Cuzco Ind. St.	t Chinchero Indians
		Initial Reading			
U. S. White	99.46 °F.	.58°F.	2.87*	2.88*	1.78
Cuzco White St.	98.39	.73		0.46	2.03*
Cuzco Indian St.	98.52	.48			2.14*
Chinchero Ind.	98.90	.49			
		20 Min. Exposure			
U. S. White	99.22	.63	2.32 *	2.19*	1.07
Cuzco White St.	98.32	.73		0.51	2.19*
Cuzco Ind. St.	98.46	.49			2.30*
Chinchero Ind.	98.87	.46			
		40 Min. Exposure			
U. S. White	99.16	.59	2.70 *	2.30 *	1.15
Cuzco White St.	98.22	.58		.82	2.73**
Cuzco Ind. St.	98.40	.46			2.25*
Chinchero Ind.	98.80	.48			
		60 Min. Exposure			
U. S. White	99.02	.63	2.44 *	2.18 *	1.29
Cuzco White St.	98.15	.55		.53	2.22*
Cuzco Ind. St	98.27	.48			1.84
Chinchero Ind.	98.60	.48			
		80 Min. Exposure			
U. S. White	98.92	.60	2.65 *	2.28 *	1.32
Cuzco White St.	98.01	.52		.53	2.49*
Cuzco Ind. St.	98.13	.55			1.85
Chinchero Ind.	98.50	.48			
		100 Min. Exposure			
U. S. White	98.82	.69	2.34 *	2.05	1.41
Cuzco White St.	97.93	.51		0.41	1.95
Cuzco Indian St.	98.03	.56			1.38
Chinchero Ind.	98.31	.50			
		120 Min. Exposure			
U. S. White	98.86	.62	2.58 *	2.17 *	1.65
Cuzco White	97.97	.47		0.39	1.83
Cuzco Indian St.	98.07	.64			1.11
Chinchero Ind.	98.31	.52			

Mean Weighted Skin Temperature

Group	Mean	S.D.	t Cuzco White St.	t Cuzco Ind. St.	t Chinchero Indians
		Initial Reading			
U. S. White	82.60°F	0.89°F	3.93**	4.00**	6.71**
Cuzco White St.	84.83	1.09		0.05	2.85**
Cuzco Indian St.	84.86	1.14			2.84**
Chinchero Ind.	86.10	1.25			
		20 Min. Exposure			
U. S. White	82.16	1.11	3.32**	3.23**	5.26**
Cuzco White St.	84.35	1.10		0.07	2.32*
Cuzco Ind. St.	84.39	1.36			2.23*
Chinchero Ind.	85.36	1.15			
		40 Min. Exposure			
U. S. Whites	81.84	1.19	3.02**	3.29**	4.66**
Cuzco White St.	83.96	1.14		0.41	1.93
Cuzco Ind. St.	84.18	1.28			1.36
Chinchero Ind.	84.77	0.92			
		60 Min. Exposure			
U. S. White	81.54	1.11	2.89**	3.37**	4.78*
Cuzco White St.	83.57	1.33		0.29	1.68
Cuzco Indian St.	83.73	1.11			1.63
Chinchero Ind.	84.37	0.92			
		80 Min. Exposure			
U. S. White	81.86	1.35	2.00	2.10	3.55**
Cuzco White St.	83.38	1.19		0.20	2.35*
Cuzco Indian St.	83.48	1.25			2.04*
Chinchero Ind.	84.37	1.02			
		100 Min. Exposure			
U. S. White	81.94	1.23	1.68	2.28*	3.46**
Cuzco White St.	83.15	1.32		0.80	2.42*
Cuzco Indian St.	83.55	1.15			1.60
Chinchero Ind.	84.23	1.14			
		120 Min Exposure			
U. S. White	81.84	1.19	2.51*	2.34*	3.48**
Cuzco White St.	83.62	1.21		0.15	1.03
Cuzco Indian St.	83.53	1.37			1.15
Chinchero Ind.	84.09	1.18			

* $P < .05$
** $P < .01$

some exceptions with the American White group showing the highest forearm temperature at some periods of time. At no point in the test are any of the body temperature differences between the student Whites and student Indians significantly different from each other. Figure 7 shows the results of the temperature measurements made in this study, plotted over the 120 minute cooling period.

Since no measure of metabolic activity was made during these tests it is not possible to present a precise picture of what is happening in terms of temperature regulation. However, the higher rectal temperature and lower skin temperature of the U. S. White group indicates that they have the highest tissue insulation of the four groups. The fact that the Indian group in Chinchero has a high rectal and a high skin temperature suggests that with cold exposure they are responding with a higher metabolic heat production than are the two student populations.

TABLE 6

Fingers Immersed 60 Min. in 32° F. Water

Temperature Cycling Characteristics

Derived Measurement	Highland Students Whites N=26 Mean	SD	Highland Students Indians N=23 Mean	SD	Chinchero Villagers Indians N=33 Mean	SD
Time before 1st rewarming cycle	9.94 min.	4.07 min.	8.91 min.	3.33 min	8.03 min.	2.38 min
Temperature before 1st rewarming cycle	34.70 °F.	1.80 °F.	35.96 °F.	3.17 °F.	35.78 °F.	2.90 °F.
Amplitude of rewarming cycle	10.98 °F.	3.96 °F.	11.88 °F.	4.19 °F.	10.62 °F.	5.09 °F.

Hand Cooling Study. All three of the Peruvian groups analyzed in the hand cooling study show a high percentage of individuals with significant rewarming in the finger. Over the one hour period of time during which the test was conducted only one test subject failed to show significant rewarming. The complex nature of the temperature cycling which occurs during this kind of study makes analysis somewhat difficult. Of the seven different measures used to analyze temperature cycling characteristics, only the three presented in Table 6 demonstrated consistantly significant differences between groups. These three were all concerned with the initial drop and subsequent first rewarming of the fingers. The Chinchero group showed the shortest time before first rewarming. The highland student group of Indians had the highest finger

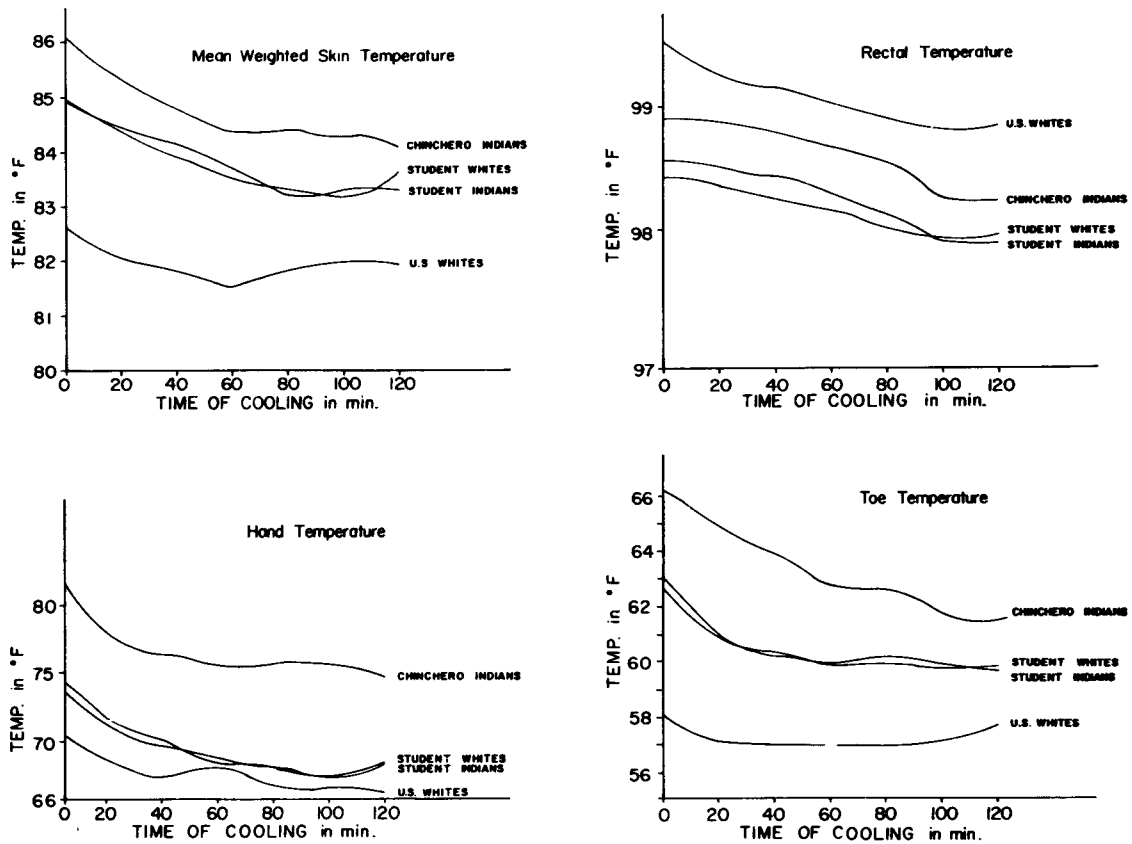

FIGURE 7
BODY COOLING AT 14°C

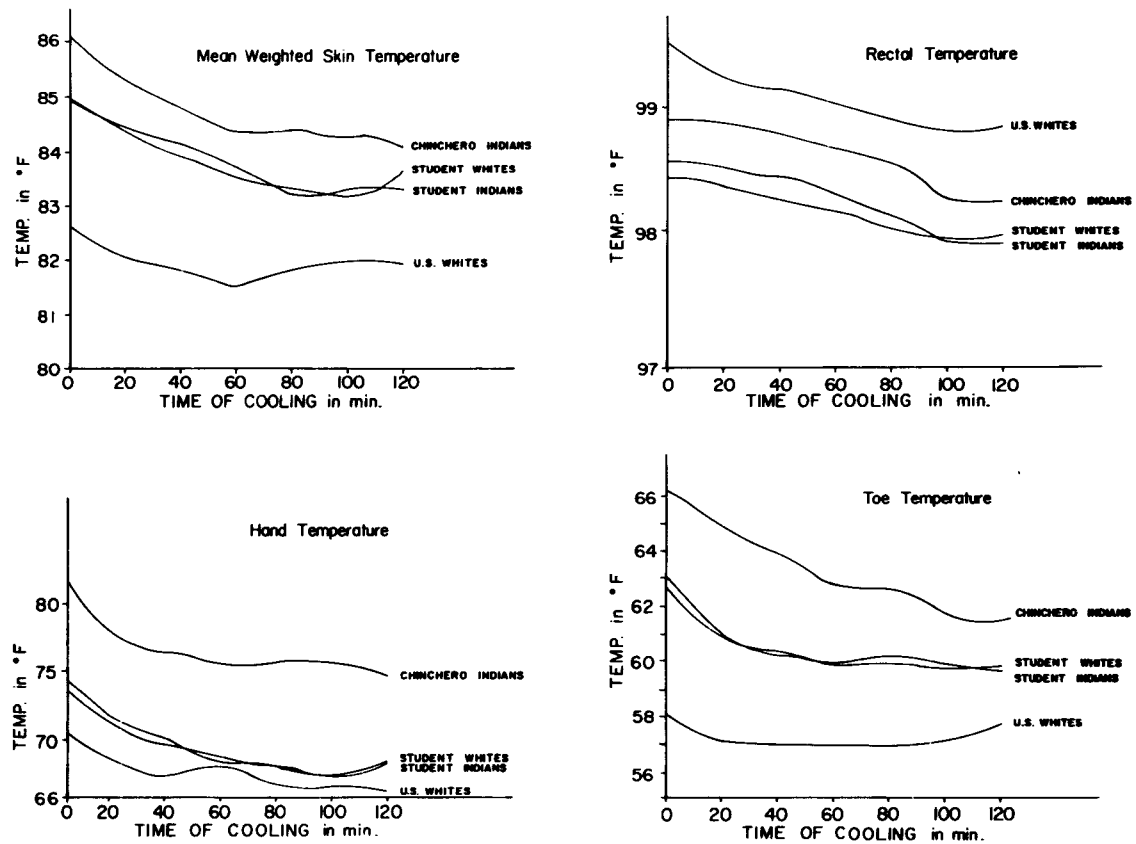

FIGURE 7
BODY COOLING AT 14°C

TABLE 7

Fingers Immersed 60 Min. in 32 °F. Water

Derived Measure	Highland Students Whites Mean	N=26 SD	Highland Students Indians Mean	N=23 SD	Chinchero Villagers Indians Mean	N=33 SD
Mean Temp. 1st 30 Min.	39.51 °F.	3.17 °F.	40.95 °F.	2.85°F.	40.28 °F.	2.75 °F.
Mean Temp. 2nd 30 Min.	39.85	3.67	40.96	2.81	40.42	3.24
Minimum Finger Temp.	34.32	1.67	35.08	2.65	35.04	1.87
Maximum Finger Temp.	45.25	4.55	45.50	3.92	36.70	3.89

temperature at the end of the initial drop and they also had the highest amplitude of rewarming. In comparing the three groups, it was found that the two Indian groups were significantly different from the White student group. However, the two Indian groups were not significantly different from each other in any of these three measurements.

Table 7 presents the results for the other four measurements of temperature in the finger during the test period. None of the differences between the groups are significant at the .05 level or better when tested by the simple t test. However, it seems worthwhile to note that the highland students showed the highest mean finger temperature throughout the test, they had the highest maximum finger temperature and on the average their finger temperature did not drop as low as did the other two groups. In subsequent order of rank, the Chinchero group is second and the student Whites last. Furthermore the differences between the Indian groups and the White group appear to be greater than the differences between the Indian groups. This, of course, follows the same pattern shown in the intital cycle measurements presented in the previous table, but does not reach the same level of statistical significance. The use of the t test may be questioned in its application to these results since some of the measurements used are significantly skewed. Differences therefore may be more or less significant than the t test shows. Other forms of statistical testing of differences are being explored and these results will be in the final report. However, the results as presently analyzed indicate the possibility of a genetic difference between the Indian and White population which is significant to finger temperatures under extreme cold exposure.

The fact that the Chinchero group was tested under different conditions than the student groups makes it possible that a difference between them and the students exists although it was not found in this study. On the other hand, the student groups were not only tested under identical conditions but also had cultural and physical environmental backgrounds which were quite similar. The preponderance of evidence, therefore, suggests that the difference between Indian and White genetic inheritance was of more significance than life history.

Discussion and Conclusions from Physiological and Anatomical Studies.

The results of the physiological studies on cold adaptation in the Chinchero group demonstrate that there are biological as well as cultural adaptations to cold in this group. In viewing the comparison of the student, U. S. White and Chinchero populations, it appears that the Chinchero native has made an acclimatizational response to total body chilling and that this response is the product of a higher metabolic output in relation to cold even when voluntary activity is inhibited. This contrasts with the temperature responses of the U. S. Whites, who had higher internal and lower skin temperatures suggesting protection against cold through the presence of greater tissue insulation. When the analysis of body structure and composition in relation to cold has been completed, a more definitive statement should be possible concerning this problem. While the adaptation to total body cold among the Chinchero natives appears to be an acclimatizational difference from other groups, the difference which appears in the response to severe cooling of the hand, suggests a genetic adaptation. Whether the difference discovered is a matter of a greater volume of blood flow to the extremity or simply less vaso-constriction cannot be determined from the data available.

It should not be concluded that this genetic difference arose in direct response to climatic selection. At least one alternative explanation can be offered. It is well recognized that the Highland Indian is better adapted to altitude than the European even if the European has spent his lifetime at this high altitude. The mechanisms whereby the Indian has become better adapted to the altitude are only partially known, but it has been shown that they have a higher hematocrit count, larger lungs, larger heart, and from the study of non-human animals it has been suggested that they also have a larger arterio-vascular system. This, of course, presents the possibility that the higher temperatures found in the fingers are a collateral or side effect from the adjustment to altitude since many of the above differences could lead to a higher core to finger heat flow.

SUMMARY OF INTEGRATION BETWEEN CULTURAL AND BIOLOGICAL ADJUSTMENTS TO HIGH ALTITUDE COLD.

As was hypothesized in the beginning of this report, the data bear out the assumption that the culture and biology of the human group supplement and complement each other in the process of man's accommodation to environmental stress. In an analysis of the human responses to cold in the highlands of Peru, it was found that man has utilized both the culture form and his own biological mechanism for the accommodation. Making use of the technology which he has available he provides a protective material culture, which limits the cold exposure in his micro-environment. However, the cultural adjustment to the cold stress was limited by the characteristics of the physical environment, the limitations of the methods available within the technology and finally by the integration with adaptations to other aspects of stress in the environment. In the highlands of Peru, the total material culture does not provide a complete protection from either moderate total body cold stress or more severe cold stress to the extremities.

Within the possibilities available, the culture also modifies the human behavior pattern in such a way that it provides additional protection against the cold. In this culture the behavioral adjustments include integration of sleeping behavior, sleeping and waking patterns and the cooking and eating patterns with periods of cold stress. However, even this additional protection provided by the culture still did not eliminate the existence of significant total body and extremity cold stress. It thus appears from the study of the structure and functioning of this group, that further accommodations have been made by the organism itself. These accommodations include a process of cold acclimatization probably through increased metabolism. They also seem to include, accommodation to extreme peripheral cold through idiosyncratic genetic structure. Of course, it cannot be concluded that the genetic adaptation implied by the differences in the hand temperatures arose strictly in response to the culture's inability to protect from cold. Quite the opposite may be the case since it is possible that greater resistance to tissue damage from cold in the hands arose as a side product of altitude adaptation and because it existed in the population, the cultural accommodation did not require as much protection from cold to hands and feet as might have been required in a group lacking this genetic characteristi

STUDIES OF ACCOMMODATION TO JUNGLE HOT-WET CONDITIONS

A cultural and biological study of native group adaptation to jungle conditions in Peru was also made. This study followed a similar methodology to that reported for the cold studies with of course appropriately different sutdies of the physiological adaptations to heat. Results of these sutdies will be presented in the final report.

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APPENDIX A

RELIABILITY AND REPRODUCIBILITY OF SKIN AND RECTAL TEMPERATURES

Peru 1962
All Groups N=50

SITE NO. 1 - TOE

Time Inter.	Test Mean	Retest Mean	S.D.1	S.D. 2	r
o min.	64.02° F	63.67° F	6.54° F	4.80° F	.651
20	62.40	62.22	6.85	4.60	.609
40	61.53	61.78	5.05	4.64	.530
60	60.87	60.96	4.06	3.81	.635
80	60.97	61.02	3.84	4.14	.472
100	60.37	60.69	2.80	3.00	.676
120	60.57	60.66	2.64	2.68	.473

SITE NO. 2 - INSTEP

0	71.66	72.41	5.36	4.35	.468
20	70.71	71.23	4.86	3.85	.363
40	69.38	69.72	4.84	3.38	.428
60	68.22	68.59	4.29	3.00	.476
80	67.12	67.51	4.08	3.75	.209
100	66.37	66.80	3.64	2.54	.474
120	66.17	66.25	3.33	2.39	.496

SITE NO. 3 - CALF

0	82.74	82.57	3.24	2.85	.341
20	81.33	81.74	2.72	2.89	.206
40	80.70	80.69	2.80	2.84	.145
60	79.51	79.48	2.79	2.76	.142
80	79.00	79.02	2.47	2.09	.377
100	78.44	78.61	2.77	2.38	.216
120	78.31	78.52	2.38	2.40	.396

SITE NO. 4 - INNER THIGH

Time Inter.	Test Mean	Retest Mean	S.D.1	S.D.2	r
0 min.	87.38° F	87.17° F	3.53° F	3.27° F	.505
20	88.77	88.62	4.18	4.04	.516
40	89.23	89.46	4.15	4.34	.497
60	89.61	89.83	4.19	4.55	.580
80	89.44	90.13	4.39	4.14	.522
100	90.15	90.19	4.30	4.35	.557
120	90.57	90.55	4.17	4.49	.556

SITE NO. 5 - OUTER THIGH

0	84.09	83.66	2.84	2.94	.484
20	83.15	82.44	2.93	2.76	.199
40	82.35	81.94	2.72	2.56	.241
60	81.55	81.45	2.84	2.75	.317
80	81.52	81.54	2.61	2.79	.168
100	81.16	81.78	2.67	3.06	.145
120	81.05	81.69	2.70	3.01	.112

SITE NO. 6 - UPPER ARM

0	84.98	85.19	3.34	2.57	.434
20	82.13	82.60	3.60	3.12	.362
40	80.95	81.11	3.19	2.83	.289
60	80.53	80.45	2.87	2.65	.330
80	79.98	80.03	2.87	2.71	.407
100	79.52	79.56	2.83	2.70	.364
120	79.42	79.87	2.82	3.06	.365

SITE NO. 7 - FOREARM

0	84.83	85.98	3.12	3.71	.188
20	82.05	83.72	2.79	2.46	.376
40	81.11	82.17	2.64	2.26	.415
60	79.82	81.63	2.45	2.15	.435
80	79.62	80.95	2.48	2.78	.359
100	79.75	80.65	3.15	2.90	.412
120	79.36	80.46	3.08	2.99	.327

SITE NO. 8 - HAND

Time Inter.	Test Mean	Retest Mean	S.D.1	S.D.2	r
0	76.42	77.35	6.21	5.13	.605
20	73.64	74.37	5.30	5.30	.650
40	72.44	72.70	5.06	4.87	.618
60	71.70	71.82	4.88	4.82	.615
80	70.99	71.88	4.96	5.55	.706
100	70.40	71.83	4.95	5.43	.691
120	70.86	71.31	5.01	4.43	.613

SITE NO. 9 - CHEST

0	86.42	86.42	3.13	3.62	.291
20	85.61	85.64	3.64	3.00	.238
40	85.33	85.78	3.19	3.29	.366
60	85.50	86.24	2.68	3.02	.001
80	85.80	86.69	2.84	2.69	.025
100	86.48	87.14	3.32	2.39	.110
120	86.49	87.59	4.49	3.22	.086

SITE NO. 10 - BACK

0	90.33	90.72	2.11	2.81	.484
20	92.09	91.70	1.52	2.53	.433
40	92.56	92.17	1.44	1.82	.417
60	92.67	92.22	1.41	1.90	.392
80	92.97	92.35	1.35	1.59	.465
100	92.98	92.48	1.41	2.02	.382
120	93.27	92.62	1.37	2.21	.460

SITE NO. 11 - FOREHEAD

0	91.37	91.88	2.21	1.59	.346
20	91.73	91.90	3.16	2.57	.320
40	92.13	91.94	2.45	2.04	.219
60	92.10	91.56	2.04	2.20	.164
80	92.10	91.84	1.71	1.78	.394
100	91.82	91.95	1.94	1.58	.265
120	91.38	92.09	3.27	1.56	.251

RECTAL

Time Inter.	Test Mean	Retest Mean	S.D.1	S.D.2	r
0	98.77	98.79	1.26	.72	.045
20	98.69	98.72	.75	.65	.578
40	98.69	98.58	.73	.62	.530
60	98.54	98.43	.71	.59	.598
80	98.42	98.31	.74	.59	.607
100	98.26	98.20	.76	.61	.555
120	98.30	98.21	.75	.59	.611

WEIGHTED SKIN TEMPERATURE

0	85.13	85.31	2.10	1.45	.502
20	84.60	84.67	1.94	1.58	.471
40	84.16	84.24	1.78	1.52	.420
60	83.74	83.88	1.59	1.64	.436
80	83.63	83.83	1.58	1.48	.586
100	83.49	83.80	1.63	1.48	.529
120	83.48	83.86	1.71	1.48	.496

APPENDIX B

ANALYSIS OF INDIVIDUAL SKIN TEMPERATURES

Toe Temperatures

Group	Mean	SD	t-Cuzco White Students	t-Cuzco Indian Students	t-Chinchero Indians
		Initial Reading			
U. S. White	58.08	1.66	3.98**	4.37**	5.05**
Cuzco White	62.69	2.56		0.29	2.18*
Cuzco Ind.	63.00	2.56			2.01*
Chinchero Ind.	66.15	6.26			
		20 Min. Reading			
U. S. White	57.04	1.21	4.07**	4.82**	5.76**
Cuzco White	60.97	2.35		0.04	2.72**
Cuzco Ind.	61.00	1.83			2.87**
Chinchero Ind.	64.83	5.53			
		40 Min. Reading			
U. S. White	57.10	0.86	4.56**	4.84**	5.79**
Cuzco White	60.42	1.81		0.08	2.85**
Cuzco Ind.	60.35	1.76			2.97**
Chinchero Ind.	63.96	5.06			
		60 Min. Reading			
U. S. White	57.00	0.97	4.03**	4.25**	5.59**
Cuzco White	59.89	1.67		0.09	2.75**
Cuzco Ind.	59.95	1.64			2.73**
Chinchero Ind.	62.80	4.20			
		80 Min. Reading			
U. S. White	56.98	0.96	4.57**	4.15**	5.83**
Cuzco White	59.95	1.38		0.46	2.88**
Cuzco Ind.	60.32	2.13			2.25*
Chinchero Ind.	62.73	3.94			
		100 Min. Reading			
U. S. White	57.24	0.68	4.75**	4.35**	6.41**
Cuzco White	59.79	1.96		0.26	2.76**
Cuzco Ind.	59.96	1.74			2.32*
Chinchero Ind.	61.89	2.95			
		120 Min Reading			
U. S. White	57.86	0.47	4.27**	4.25**	6.26**
Cuzco White	59.87	1.28		0.81	2.51*
Cuzco Ind.	60.43	1.85			1.47
Chinchero Ind.	61.57	2.50			

* P>.05 ** P>.01

Instep Temperature

Group	Mean	SD	t-Cuzco White Students	t-Cuzco Indian Students	t-Chinchero Indians
		Initial Reading			
U. S. White	70.22	3.57	1.31	1.18	0.69
Cuzco White	73.02	3.74		0.35	0.85
Cuzco Ind.	72.52	2.62			0.65
Chinchero Ind	71.65	4.93			
		20 Min. Exposure			
U. S. White	68.60	3.01	1.86	1.63	1.21
Cuzco White	72.09	3.55		0.58	0.97
Cuzco Ind.	71.31	2.36			0.54
Chinchero Ind.	70.73	4.01			
		40 Min. Exposure			
U. S. White	67.02	2.48	2.44*	1.99	1.46
Cuzco White	70.87	3.06		0.84	1.25
Cuzco Ind.	69.87	2.32			0.56
Chinchero Ind.	69.24	4.02			
		60 Min. Exposure			
U. S. White	66.36	1.78	2.54*	2.11*	1.49
Cuzco White	69.39	2.52		0.74	1.04
Cuzco Ind.	68.64	2.03			0.44
Chinchero Ind.	68.18	3.85			
		80 Min. Exposure			
U. S. White	65.40	1.43	2.38*	1.79	1.86
Cuzco White	68.22	2.99		0.94	0.72
Cuzco Ind.	67.14	2.17			0.26
Chinchero Ind.	67.35	3.51			
		100 Min. Exposure			
U. S. White	64.62	1.16	2.41*	3.04**	2.19*
Cuzco White	66.63	1.30		0.57	0.43
Cuzco Ind.	67.10	1.89			0.47
Chinchero Ind.	66.67	3.35			
		120 Min. Exposure			
U. S. White	64.18	1.31	2.71*	2.83*	2.24*
Cuzco White	66.44	1.62		0.25	0.19
Cuzco Ind.	66.62	1.86			0.40
Chinchero Ind.	66.28	3.06			

* $P > .05$ ** $P > .01$

Calf Temperature

Group	Mean	SD	t-Cuzco White Student	t-Cuzco Indian Students	t-Chinchero Indians
		Initial Reading			
U. S. White	81.14	2.33	2.00	1.81	0.65
Cuzco White	83.65	1.47		0.28	2.11*
Cuzco Ind.	83.46	1.72			1.78
Chinchero Ind.	82.00	2.90			
		20 Min. Exposure			
U. S. White	80.46	1.92	1.98	1.82	0.71
Cuzco White	82.57	1.45		0.09	1.95
Cuzco Ind.	82.51	1.97			1.63
Chinchero Ind.	81.23	2.33			
		40 Min. Exposure			
U. S. White	79.44	2.36	1.74	1.64	0.44
Cuzco White	81.58	1.10		0.03	2.68*
Cuzco Ind.	81.60	1.96			2.11*
Chinchero Ind.	80.00	2.17			
		60 Min Exposure			
U. S. White	77.64	1.94	1.98	2.75*	1.28
Cuzco White	80.00	2.22		0.71	1.27
Cuzco Ind.	80.61	1.60			2.59*
Chinchero Ind.	78.98	1.84			
		80 Min. Exposure			
U. S. White	77.98	1.65	1.70	1.99	0.46
Cuzco White	79.57	1.40		0.50	1.90
Cuzco Ind.	79.91	1.68			2.27*
Chinchero Ind.	78.40	1.95			
		100 Min. Exposure			
U. S. White	77.42	1.13	1.46	2.86*	0.84
Cuzco White	78.65	1.97		1.23	0.84
Cuzco Ind.	79.68	1.83			2.40*
Chinchero Ind.	78.01	1.95			
		120 Min. Exposure			
U. S. White	77.18	1.57	2.09	2.22*	0.69
Cuzco White	79.07	1.43		0.37	2.00
Cuzco Ind.	79.34	1.91			2.11*
Chinchero Ind.	77.80	2.03			

* $P > .05$ ** $P > .01$

Inner Thigh

Group	Mean	SD	t-Cuzco White Students	t-Cuzco Indian Students	t-Chinchero Indians
		Initial Reading			
U. S. White	83.18	2.26	2.00	3.06**	4.58**
Cuzco White	85.84	2.20		1.44	3.50**
Cuzco Ind.	87.25	2.29			1.89
Chinchero Ind.	88.90	2.42			
		20 Min. Exposure			
U. S. White	83.54	3.40	2.00	2.59*	3.78**
Cuzco White	87.60	3.36		0.77	2.34*
Cuzco Ind.	88.73	3.34			1.44
Chinchero Ind.	90.35	2.31			
		40 Min. Exposure			
U. S. White	83.52	3.81	2.00	3.27*	3.66**
Cuzco White	88.07	3.90		1.52	2.00
Cuzco Ind	90.32	2.72			0.42
Chinchero Ind.	90.73	2.21			
		60 Min. Exposure			
U. S. White	83.56	3.73	2.11*	3.49**	3.96**
Cuzco White	88.38	4.17		1.46	2.00
Cuzco Ind.	90.64	2.68			0.61
Chinchero Ind.	91.24	2.50			
		80 Min. Exposure			
U. S. White	84.18	4.10	1.88	2.96**	3.50**
Cuzco White	88.60	3.63		1.50	2.35*
Cuzco Ind.	90.74	2.80			0.87
Chinchero	91.64	2.69			
		100 Min. Exposure			
U. S. White	84.48	4.08	1.75	3.06**	3.38**
Cuzco White	88.67	4.03		1.67	2.12*
Cuzco Ind.	91.15	2.54			0.50
Chinchero Ind.	91.63	2.57			
		120 Min. Exposure			
U. S. White	84.62	4.06	2.04	3.12**	3.45**
Cuzco White	89.58	4.23		1.18	1.59
Cuzco Ind.	91.40	2.54			0.51
Chinchero Ind.	91.88	2.53			

* P> .05 ** P>.01

Outer Thigh

Group	Mean	SD	t-Cuzco White Students	t-Cuzco Indian Students	t-Chinchero Indians
		Initial Reading			
U. S. White	81.64	1.82	1.46	0.73	3.75**
Cuzco White	83.16	1.63		0.84	3.33**
Cuzco Ind.	82.48	2.27			3.64**
Chinchero Ind.	85.45	2.05			
		20 Min. Exposure			
U. S. White	80.52	2.88	1.04	1.12	2.26*
Cuzco White	82.07	1.33		0.24	3.06**
Cuzco Ind.	82.23	1.73			2.48*
Chinchero Ind.	83.91	1.93			
		40 Min. Exposure			
U. S. White	79.98	2.45	1.33	1.36	2.33*
Cuzco White	81.68	1.23		0.22	2.29*
Cuzco Ind.	81.83	1.95			1.60
Chinchero Ind.	82.99	1.93			
		60 Min. Exposure			
U. S. White	78.86	2.96	1.58	1.44	2.25*
Cuzco White	81.30	1.38		0.15	1.66
Cuzco Ind.	81.18	2.16			1.45
Chinchero Ind.	82.32	1.97			
		80 Min. Exposure			
U. S. White	80.54	2.77	0.44	0.38	1.08
Cuzco White	81.18	1.41		0.10	1.47
Cuzco Ind.	81.10	1.91			1.38
Chinchero Ind.	82.11	2.05			
		100 Min. Exposure			
U. S. White	80.98	3.21	0.07	0.25	0.52
Cuzco White	80.86	1.30		0.74	1.56
Cuzco Ind.	81.42	2.08			0.54
Chinchero Ind.	81.84	2.19			
		120 Min. Exposure			
U. S. White	81.00	2.74	0.16	0.18	0.36
Cuzco White	81.23	1.31		0.07	0.45
Cuzco Ind.	81.28	2.01			0.31
Chinchero Ind.	81.52	2.35			

* P .05 ** P .01

Upper Arm

Group	Mean	SD	t-Cuzco White Students	t-Cuzco Indian Students	t-Chinchero Indians
		Initial Reading			
U. S. White	81.48	2.90	2.16*	1.78	3.29**
Cuzco White	84.70	1.08		0.46	3.21**
Cuzco Indians	84.34	2.33			2.57*
Chinchero Ind.	86.44	1.93			
		20 Min. Exposure			
U. S. White	79.20	2.98	1.72	1.29	2.92**
Cuzco White	81.88	1.41		0.37	2.92**
Cuzco Ind.	81.49	3.22			2.10*
Chinchero Ind.	83.74	2.06			
		40 Min. Exposure			
U. S. White	77.76	3.03	1.75	1.77	2.79**
Cuzco White	80.50	1.26		0.32	2.95**
Cuzco Ind.	80.78	2.63			1.51
Chinchero Ind.	82.10	1.70			
		60 Min Exposure			
U. S. White	78.28	2.86	1.27	0.85	2.22*
Cuzco White	80.15	1.24		0.75	2.49*
Cuzco Ind.	79.60	2.07			2.64*
Chinchero Ind.	81.59	1.94			
		80 Min. Exposure			
U. S. White	78.28	3.37	0.53	0.39	1.75
Cuzco White	79.18	0.91		0.28	4.18**
Cuzco Ind.	78.98	2.13			3.04**
Chinchero Ind.	81.32	1.93			
		100 Min. Exposure			
U. S. White	78.46	3.61	0.14	0.15	1.81
Cuzco White	78.72	1.29		0.02	3.12**
Cuzco Ind.	78.74	1.93			2.54*
Chinchero Ind.	80.59	1.98			
		120 Min Exposure			
U. S. White	78.62	3.47	0.27	0.03	1.13
Cuzco White	79.09	0.97		0.55	2.65*
Cuzco Ind.	78.67	2.34			2.30*
Chinchero Ind.	80.65	2.30			

* $P > .05$ ** $P > .01$

Forearm Temperature

Group	Mean	SD	t-Cuzco White Students	t-Cuzco Indian Students	t-Chinchero Indians
		Initial Reading			
U. S. White	84.84	0.84	0.85	0.57	2.79**
Cuzco White	83.96	2.99		0.42	2.55*
Cuzco Ind.	84.43	1.93			2.93**
Chinchero	86.72	2.41			
		20 Min. Exposure			
U. S. White	82.38	1.54	0.11	0.36	1.46
Cuzco White	82.28	1.59		0.33	2.06*
Cuzco Ind.	82.00	2.35			2.00
Chinchero Ind.	83.70	2.16			
		40 Min Exposure			
U. S. White	81.70	1.23	0.36	1.43	0.96
Cuzco White	81.43	1.41		1.28	1.63
Cuzco Ind.	80.31	2.50			2.45 *
Chinchero Ind.	82.40	1.81			
		60 Min. Exposure			
U. S. White	81.70	1.56	1.40	2.31*	0.44
Cuzco White	80.12	1.52		1.30	1.48
Cuzco Ind.	79.39	2.07			2.64 *
Chinchero Ind.	81.32	1.73			
		80 Min. Exposure			
U. S. White	81.66	1.43	2.49*	3.14**	0.60
Cuzco White	79.48	1.96		0.95	2.53*
Cuzco Ind.	78.74	1.97			3.30**
Chinchero Ind.	81.15	1.97			
		100 Min Exposure			
U. S. White	82.00	1.74	2.61*	3.71**	0.65
Cuzco White	79.10	2.17		0.99	2.64*
Cuzco Indians	78.25	1.68			4.33**
Chinchero Ind.	81.35	2.32			
		120 Min. Exposure			
U. S. White	81.68	1.65	2.39 *	3.17**	0.94
Cuzco White	78.97	2.44		0.64	2.03*
Cuzco Ind.	78.32	2.20			3.07**
Chinchero Ind.	80.79	2.09			

* P> .05 ** P> .01

Hand Temperature

Group	Mean	SD	t-Cuzco White Students	t-Cuzco Indian Students	t-Chinchero Indians
		Initial Reading			
U. S. White	70.74	1.69	2.88*	2.95**	8.54**
Cuzco White	73.85	2.12		0.42	6.61**
Cuzco Ind.	74.31	2.86			5.56**
Chinchero Ind.	81.15	4.03			
		20 Min. Exposure			
U. S. White	68.88	1.62	2.65*	1.98	7.46**
Cuzco White	71.39	1.51		0.24	6.41**
Cuzco Ind	71.67	2.73			5.55**
Chinchero Ind.	77.98	4.16			
		40 Min. Exposure			
U. S. White	67.60	1.61	2.20*	2.24*	8.11**
Cuzco White	69.65	1.43		0.44	7.84**
Cuzco Ind.	70.03	2.43			6.19**
Chinchero Ind.	76.51	3.43			
		60. Min. Exposure			
U. S. White	68.30	2.13	0.57	0.29	5.57**
Cuzco White	68.93	0.82		0.33	5.35**
Cuzco Ind.	68.68	2.35			6.63**
Chinchero Ind.	75.59	3.50			
		80 Min Exposure			
U. S. White	66.78	2.00	1.26	1.15	7.13**
Cuzco White	68.18	1.56		1.67	8.34**
Cuzco Ind.	68.36	3.11			6.12**
Chinchero Ind.	75.75	3.49			
		100 Min. Exposure			
U. S. White	66.82	1.96	0.90	0.68	7.26**
Cuzco White	67.84	1.87		0.21	8.40**
Cuzco Ind.	67.65	2.38			7.88**
Chinchero Ind.	75.55	3.21			
		120 Min. Exposure			
U. S. White	66.40	1.70	2.23*	1.65	7.70**
Cuzco White	68.89	2.29		0.42	5.91**
Cuzco Ind.	68.42	2.90			5.72**
Chinchero Ind.	74.70	3.00			

* P. .05 ** P .01

Chest Temperature

Group	Mean	SD	t-Cuzco White Students	t-Cuzco Indian Students	t-Chinchero Indians
		Initial Reading			
U. S. White	85.34	0.88	1.71	0.89	1.59
Cuzco White	86.61	1.88		0.41	0.05
Cuzco Ind.	86.19	2.80			0.42
Chinchero	86.65	3.19			
		20 Min. Exposure			
U. S. White	84.32	1.90	0.57	0.89	1.74
Cuzco White	84.94	1.60		0.49	1.67
Cuzco Ind.	85.33	2.10			1.10
Chinchero Ind.	86.36	3.15			
		40 Min. Exposure			
U. S. White	84.22	2.16	0.86	0.95	1.41
Cuzco White	85.31	2.07		0.09	0.76
Cuzco ILd.	85.38	1.91			0.72
Chinchero Ind.	86.04	3.23			
		60 Min. Exposure			
U. S. White	85.62	1.94	0.12	0.02	0.43
Cuzco White	85.76	1.99		0.20	0.40
Cuzco Ind.	85.60	1.69			0.69
Chinchero Ind.	86.08	2.21			
		80 Min. Exposure			
U. S. White	86.18	1.88	0.30	0.39	0.15
Cuzco White	86.52	2.08		0.96	0.23
Cuzcc Ind.	85.78	1.29			0.91
Chinchero Ind.	86.33	2.12			
		100 Min. Exposure			
U. S. White	86.64	1.71	0.48	0.16	0.16
Cuzco White	87.15	1.94		0.88	0.45
Cuzco White	86.48	1.47			0.49
Chinchero Ind.	86.80	2.18			
		120 Min. Exposure			
U. S. White	86.14	2.86	1.26	0.06	0.70
Cuzco White	88.10	1.99		1.67	1.04
Cuzco Ind.	86.03	3.56			0.98
Chinchero Ind.	87.22	2.58			

* P .05 ** P .01

Group	Mean	SD	t-Cuzco White Students	t-Cuzco Indian Students	t-Chinchero Indians
		Initial Reading			
U. S. White	86.54	1.98	3.21**	3.83**	4.74**
Cuzco White	90.27	1.94		0.40	1.74
Cuzco Ind.	90.55	1.11			1.99
Chinchero Ind.	91.49	1.51			
		20 Min. Exposure			
U. S. White	89.24	1.50	3.06**	3.57**	3.65**
Cuzco White	92.00	1.59		0.15	0.67
Cuzco Ind.	92.10	0.94			0.98
Chinchero Ind.	92.28	1.67			
		40 Min. Exposure			
U. S. White	90.54	0.48	3.70**	4.47**	5.72**
Cuzco White	92.65	1.62		0.41	0.10
Cuzco Ind.	92.39	1.11			0.46
Chinchero Ind.	92.59	1.22			
		60 Min. Exposure			
U. S. White	90.94	0.63	3.11**	3.09**	3.86**
Cuzco White	92.75	1.54		0.45	0.32
Cuzco Ind.	92.47	1.26			0.21
Chinchero INd.	92.56	1.27			
		80 Min. Exposure			
U. S. White	91.08	0.87	2.86*	2.71*	3.74**
Cuzco White	92.87	1.43		0.38	0.01
Cuzco ILd.	92.65	1.27			0.52
Chinchero Ind.	92.88	0.95			
		100 Min. Exposure			
U. S. White	90.78	0.92	1.95	1.93	1.83
Cuzco White	93.07	1.42		0.21	0.52
Cuzco INd.	92.96	1.04			0.37
Chinchero Ind.	92.81	1.03			
		120 Min. Exposure			
U. S. White	91.02	2.74	1.71	1.58	1.36
Cuzco White	93.45	1.27		0.31	1.24
Cuzco Ind.	93.27	1.36			0.83
Chinchero Ind.	92.86	0.95			

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Forehead Temperatures

Group	Mean	SD	t-Cuzco White Students	t-Cuzco Indian Students	t-Chinchero Indians
		Initial Reading			
U. S. White	89.86	2.00	1.88	1.63	1.89
Cuzco White	91.87	1.18		0.47	0.04
Cuzco Ind.	91.62	1.30			0.47
Chinchero Ind.	91.85	1.51			
		20 Min. Exposure			
U. S. White	90.30	3.05	1.48	1.10	0.75
Cuzco White	92.64	1.24		0.67	1.71
Cuzco Ind.	92.13	2.17			0.73
Chinchero	91.51	2.44			
		40 Min. Exposure			
U. S. White	90.72	2.03	.144	1.79	1.00
Cuzco White	92.34	1.51		0.49	0.82
Cuzco Ind.	92.62	1.01			1.55
Chinchero Ind.	91.81	1.91			
		60 Min. Exposure			
U. S. White	89.42	1.57	3.31**	3.42**	3.79**
Cuzco White	92.25	1.06		0.26	0.90
Cuzco Ind.	92.38	1.02			1.12
Chinchero Ind.	91.81	1.58			
		80 Min. Exposure			
U. S. White	89.68	1.30	3.24**	3.44**	3.61**
Cuzco White	92.05	1.06		0.32	0.49
Cuzco Ind.	92.20	1.13			0.15
Chinchero Ind.	92.27	1.39			
		100 Min. Exposure			
U. S. White	90.20	1.06	2.93**	3.13**	2.94**
Cuzco White	91.96	0.85		0.44	0.21
Cuzco Ind.	92.15	1.09			0.20
Chinchero Ind.	92.05	1.57			
		120 Min. Exposure			
U. S. White	90.22	0.99	3.09**	3.32**	1.78
Cuzco White	92.06	1.04		0.45	0.80
Cuzco Ind.	92.29	1.25			1.11
Chinchero Ind.	91.54	2.56			

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